ANNUAL STANDARDS AND SPECIFICATIONS FOR EROSION & SEDIMENT CONTROL AND STORMWATER MANAGEMENT

VIRGINIA PROJECTS

Revised January 2021

TC Energy

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i. Document Preparation

This document has been prepared by Arcadis of New York, Inc., a third-party consultant of TC Energy.

ii. Document Certification

"I certify under penalty of law that all documents and all attachments related to the submission and updating of the TC Energy Annual Standards and Specifications for Erosion and Sediment Control and Stormwater Management have been prepared under my direction or supervision in a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of a fine and imprisonment for knowing violations."

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I. Introduction

TC Energy is committed to conducting its operations in compliance with the applicable environmental rules and regulations of federal, state, and local governments. TC Energy's goal is to meet these requirements in the pursuit of a cleaner, safer environment for future operations. Recognizing this goal, it is TC Energy's policy that all construction, operation, and **maintenance activities** be conducted in a safe manner that minimizes impacts to stream and **wetland** ecosystems, wildlife habitat, cultural resources, and the human environment.

To this end, TC Energy has prepared these **Annual Standards and Specifications for Erosion & Sediment Control and Stormwater Management (Annual Standards)**. The Annual Standards provide general administrative, permitting, and technical guidance to be applied to the construction, operation, and maintenance activities of linear natural gas transmission projects in Virginia and **appurtenant facilities** that are necessary for the operation of these linear utilities. Included as Appendix A to the Annual Standards are the **Environmental Construction Standards (ECS)**, which provide specific technical information pertaining to methods and practices to conduct construction activities in a manner that minimizes the potential for harming the environment.

The general objective of the Annual Standards, including the ECS, is to provide TC Energy personnel and TC Energy's contractors with instructional information outlining a practical approach to addressing environmental concerns that can arise before, during, and after facility construction. More specific objectives include:

- Minimize impacts to environmentally sensitive areas (e.g., wetlands, streams, and cultural resources);
- Use the minimum land required for safe and efficient construction, operation, and maintenance of the facilities;
- Reduce the potential for erosion and sedimentation during construction; and
- Complete construction in a safe and timely manner.

The Annual Standards aim to confine project-related disturbance to the identified **construction work areas (CWAs)** and to minimize erosion and enhance revegetation in those areas. All project-related activities must stay within the CWA, including ground disturbance, as well as all **support activities** (e.g., **extra work areas**, access routes, equipment and personnel parking, and areas for staging, borrow, or disposal) shall be included within the CWA in addition to the active construction zone.

The Annual Standards have been developed in accordance with the applicable regulations identified below in Section II and will be resubmitted annually to the **Virginia Department of Environmental Quality (VADEQ)** for review. The Annual Standards is applicable to all TC Energy wholly or partially owned subsidiaries, including **Columbia Gas Transmission,**

LLC (Columbia).

Words and/or phrases shown in **bold** at first occurrence in text and acronyms are defined in Section IV (Definition of Terms) of this document.

II. Permitting

This section provides a brief overview of potential permitting requirements associated with **erosion and sediment control (ESC)** and **stormwater management (SWM)** for TC Energy construction activities in Virginia. Given the variable nature of individual projects, applicable local, state, and federal regulations should be reviewed during the project planning phase to ensure compliance with regulatory requirements. In addition, a pre-application meeting with the regulatory authority is recommended to verify project-specific permitting requirements for projects impacting sensitive resources.

A flowchart outlining the permitting process for construction projects is included in Appendix B. The flowchart provides general guidance for permitting various types of projects and should be verified with careful regulation review and agency correspondence during initial project permitting phases.

A. Project Applicability

Applicable Projects

As noted in Section I, this document applies to all construction, installation, or maintenance of linear natural gas transmission projects (e.g., natural gas pipelines) and appurtenant facilities necessary for the operation of these **linear projects** (e.g., storage facilities including well locations, compressor stations, metering/regulation stations, access roads, and other select features). Such projects/activities shall be conducted in accordance with the Annual Standards, and site-specific plans as applicable, for both Virginia ESC and SWM regulations as described below.

Non-Applicable Projects

Non-essential ancillary features and/or roads not associated with a linear natural gas transmission project (e.g., work associated with an office, remote access road that does not lead to the pipeline or facility associated with the pipeline) are not covered under these Annual Standards and must go through the local **Virginia Erosion and Sediment Control Program (VESCP)** authority and the local or state **Virginia Stormwater Management Program (VSMP)** authority where the project is located. Although such projects are not covered under the Annual Standards and instead must comply with the requirements of VADEQ and/or local authorities (these requirements are briefly described in the sections below or otherwise included by reference), the Annual Standards can be used as a guidance document in developing permitting and construction plans to mitigate environmental impacts for non-applicable TC Energy projects.

Select Large/High Profile Projects

Select projects may require additional permitting although they are still covered under the Annual Standards. TC Energy should notify the VADEQ of any “large” (e.g., a pipeline in excess of 50 miles in length) or “high profile” (e.g., the pipeline goes through numerous wetland and waterbody features, or receives a large number of complaints from residents) projects prior to construction, as these projects may require additional permitting. This notification to the VADEQ may expedite the permitting process.

Emergency Projects

Emergency projects will be conducted when there is an immediate need of repair in order to protect life, property, or the environment. Emergency work does not fall under the VADEQ definition of a regulated **land disturbance**, nor does it fall under typical permitting methods. Emergency work, however, will be conducted in accordance with these Annual Standards.

If a site-specific **ESC Plan** and **SWM Plan** would be required based on project size (see Section II.C), then the plan(s) may be developed after the emergency work has already commenced (i.e., retroactively).

For emergency project ESC Plans, TC Energy should electronically notify the VADEQ (or the VESCP authority for non-applicable projects; see Section II.A) as soon as possible upon commencing land-disturbing activity. ESC Plans should be prepared and documented within TC Energy records.

For emergency project SWM Plans, TC Energy shall electronically notify the VADEQ (or the VSMP authority for non-applicable projects; see Section II.A) within seven days of commencing the land-disturbing activity. Emergency project SWM Plans shall be developed within 30 days of commencing the land-disturbing activity.

B. Applicable Regulations

The Annual Standards and ECS incorporate applicable Virginia ESC and SWM regulations, as amended. Local regulations should be reviewed on a project-specific basis. Applicable state regulations incorporated or referenced in this document include the following:

- Erosion and Sediment Control Law, Code of Virginia § 62.1-44.15:51 to :66;
- Erosion and Sediment Control Regulations, Administrative Code 9VAC25-840;
- Erosion and Sediment Control and Stormwater Management Certification Regulations, Administrative Code 9VAC25-850;

- Stormwater Management Act, Code of Virginia § 62.1-44.15:24 to :50;
- VSMP Regulation, Administrative Code 9VAC25-870; and
- VAR10 General Permit for Discharges of Construction Stormwater, Administrative Code 9VAC25-880.

In addition, the following support documents/reference documents are incorporated and/or referenced herein:

- **Virginia Erosion and Sediment Control Handbook (VESCH)**;
- Virginia Stormwater Management Handbook;
- Virginia Stormwater Best Management Practice Clearinghouse;
- **Guidance Memo No. 15-2003 (GM 15-2003)** – Postdevelopment Stormwater Management Implementation Guidance for Linear Utility Projects under the Virginia Stormwater Management Program Regulation, Administrative Code 9VAC25-870;
- Virginia Runoff Reduction Method Instructions and Documentation and associated Runoff Reduction spreadsheets available on the Clearinghouse;
- Guidance Memo No. 16-2001 – Updated Virginia Runoff Reduction Method Compliance Spreadsheets – Version 3.0; and
- Virginia Stream Restoration and Stabilization Best Management Practices Guide.

C. Typical Required Plans

Depending on the size of the land disturbance for a project, different site-specific plans will need to be developed prior to construction: an ESC Plan for sites disturbing greater than or equal to 10,000 square feet; a SWM Plan for sites disturbing greater than or equal to one acre, or less than one acre but part of a common plan of development; and a **Stormwater Pollution Prevention Plan (SWPPP)** for sites disturbing greater than or equal to one acre.

For projects within designated **Chesapeake Bay Preservation Areas (CBPAs**) (see Section II.J), the threshold area of land disturbance required to develop an ESC or SWM Plan is reduced to 2,500 square feet. The Annual Standards may be used as a guidance document in developing these plans, but the other VADEQ regulations listed in II.B and any local regulations also need to be reviewed and incorporated.

Prior to initiating a regulated land disturbance activity of any size, electronic notification (e.g., email) is required to be submitted to VADEQ two weeks (14 days) before initiating the activity. Email the two-week notification to standardsandspecs@deq.virginia.gov. See Section III.D for additional information on the two-week notification.

Site-Specific Erosion and Sediment Control Plans

A site-specific ESC Plan contains all the information deemed necessary to achieve the conservation goals of soil and water resources within the single or multiple land units from a construction project. Refer to the Plan Submitter's Checklist for Erosion and Sediment Control Plans in Appendix D for more information on the ESC Plan contents.

A site-specific ESC Plan is required when land disturbance is greater than or equal to 10,000 square feet, or greater than or equal to 2,500 square feet within CBPAs (see Section II.J). The ESC Plan shall be consistent with the requirements of the Virginia ESC Regulations in 9VAC25-840 (including addressing each applicable **Minimum Standard (MS)** described in 9VAC25-840-40) and the latest edition of the VESCH.

ESC Plans are not required to be submitted for approval by VADEQ or local regulatory agencies except when TC Energy seeks a permitting waiver under GM 15-2003 (Appendix C) or Minimum Standard variance request, or if the project is considered to be "large" or "high profile" (see Section II.A). If TC Energy submits a permitting waiver under GM 15-2003, or if it is a "large or "high profile" linear project, the site-specific ESC Plan must be submitted to the VADEQ for approval.

The site-specific ESC Plan must provide a description of any changes in land cover conditions and reasonable assurance that restoration practices will return the disturbed areas back to a hydrologically functional state (i.e., the project does not significantly alter predevelopment runoff characteristics after final stabilization through changes in topography or concentrating sheet flow). Practices to provide assurance are site specific and may include, but are not limited to, soil decompaction, vegetative restoration, and a maintenance regime that includes at a minimum no bush hogging more than four times per year.

Site-Specific Stormwater Management Plans

A SWM Plan contains information on measures and practices to control stormwater runoff and the characteristics of the runoff including, but not limited to, the quantity and quality of the runoff. The overall goal of the SWM Plan is to minimize impacts on receiving state waters.

The VADEQ has determined that routine maintenance performed to maintain the original line and grade, hydraulic capacity, or original construction of the project are exempt from VSMP regulations. While routine maintenance projects are exempt from VSMP requirements, these projects are still required to adhere to the ESC regulations. Maintenance activity projects include, but are not limited to (see Section IV for a longer list of maintenance activities):

- Minor maintenance on valves, taps, rectifiers, access roads, etc. (e.g., greasing valves, filling in potholes, sandblasting and painting aboveground facilities for atmospheric corrosion protection)
- Slip repairs
- Integrity digs (i.e., anomaly or leak repairs)
- Cathodic protection/AC mitigation

Projects that do not fall under the definition of maintenance activities are not exempt from SWM regulations but may still apply for a SWM Plan Waiver. For linear projects that will not result in significant changes to the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization, TC Energy can submit a SWM Plan Waiver package to the VADEQ under GM 15-2003 (Appendix C). Upon reviewing the SWM Plan Waiver package, the VADEQ, or the local VSMP authority for non-applicable projects (see Section II.A), may waive the requirement for the preparation and implementation of a SWM Plan if non-significance is determined. For any projects requesting a waiver under GM 15-2003, TC Energy is required to submit a stamped and signed site-specific ESC plan, an AS&S Entity Information Form (Appendix G) indicating a SWM Plan Waiver Request, and an official transmittal letter with TC Energy's letterhead signed by a TC Energy representative. VADEQ may also request an analysis of water quality. The VADEQ will review projects on an individual basis.

A site-specific SWM Plan is required when land disturbance is greater than or equal to one acre outside designated CBPAs, or greater than or equal to 2,500 square feet within designated CBPAs. The SWM Plan shall be consistent with the requirements of the Virginia SWM Program Regulations (9VAC25-870) and the latest edition of the Virginia Stormwater Best Management Practice Clearinghouse. Refer to the Plan Submitter's Checklist for Stormwater Management Plans in Appendix E for more information on the SWM Plan contents.

<u>Stormwater Pollution Prevention Plans</u>

The SWPPP outlines the steps an operator must take to reduce pollutants in stormwater runoff from the construction site, including water quality and quantity requirements. SWPPPs are prepared using good engineering practices and identify all potential pollutant sources that could enter stormwater leaving the construction site, and the methods used to reduce pollutants in stormwater runoff both during and after construction.

Per 9VAC25-870-380.A.2., the VADEQ may not require coverage under the **General Virginia Pollutant Discharge Elimination System (VPDES) VAR10**

General Permit for Discharges of Stormwater from Construction Activities (VAR10 GP) for the oil and gas work further detailed in the referenced section. However, projects covered under these Annual Standards with greater than or equal to 1 acre (or less than 1 acre but part of a common plan of development) are required to have a SWPPP that is consistent with 9VAC25-880. SWPPPs shall include the following items:

1. General Information
2. Erosion and Sediment Control Plan
3. Stormwater Management Plan
4. **Pollution Prevention Plan**
5. Requirements for discharges to impaired waters, surface waters with an applicable **total maximum daily load (TMDL)** wasteload allocation established and approved prior to the term of the latest approved VAR10 GP, and **exceptional state waters**.
    - Information on TMDLs can be found in the latest edition of Virginia's 305(b)/303(d) Water Quality Assessment Integrated Report. A listing of exceptional state waters can be found in the Exceptional State Waters (Tier III) section on the VADEQ's website under Water Quality Standards.
6. Contact information for qualified personnel
7. Contact information of the individuals or positions with delegated authority
8. SWPPP signature

Further details on these SWPPP requirements can be found in Part II of 9VAC25-880-70.

TC Energy's SWPPP will include, or incorporate by reference, the ESC Plan, SWM Plan, **Spill Prevention, Control, and Countermeasure (SPCC) Plan**, **Environmental Management and Construction Plan (EMCP)**, the ECS, and any other applicable plans. The Annual Standards only need to be incorporated by reference in the SWPPP. If the plans incorporated by reference do not address all of the requirements of the SWPPP, the missing elements must be included in the SWPPP.

Note that there may not be a document entitled "SWPPP", however the assemblage of the documents described above collectively can serve as the SWPPP. Furthermore, the EMCP may substitute for a separate SWPPP document, provided that the EMCP satisfies all the required components of a SWPPP outlined in this section. For projects where this occurs, additional text shall be included within the

EMCP narrative identifying the substitution and where the required components of the SWPPP are located within the EMCP, and that the EMCP is required to be on site during construction and available for inspection by VADEQ.

In addition to including the ESC Plan, SWM Plan, and pollution prevention plan requirements, the SWPPP will also address the following procedures:

- Amendments/modifications to the SWPPP when there is a change in the design, construction, operation, or maintenance that has a significant effect on discharge of pollutants to surface waters that was not already addressed in the SWPPP;

- Public notification of the SWPPP if requested by VADEQ;

- SWPPP availability at a central location on site during construction activities, and SWPPP availability upon request at various regulatory agencies, as described in Section III.F;

- SWPPP inspections (see Section III.A); and

- Corrective actions identified during inspections.

The operator shall implement corrective actions as soon as practicable, but no later than seven days after discovery or a longer period as approved by the VSMP authority. If approval of a corrective action by a regulatory authority (e.g., VADEQ, VESCP authority, VSMP authority) is necessary, additional control measures shall be implemented to minimize pollutants in stormwater discharges until such approvals can be obtained.

To resolve a corrective action, the operator may be required to remove accumulated sediment deposits located outside of the approved construction activity limits as soon as practicable in order to minimize environmental impacts. The operator shall notify the VSMP authority and the VADEQ as well as obtain all applicable federal, state, and local authorizations, approvals, and permits prior to removal of sediments accumulated in surface waters (including wetlands).

See ECS Section VI.B (Appendix A) and 9VAC25-880 Parts II G.4 and II H for more details on corrective actions.

For projects that require VAR10 GP coverage (see subsection VAR10 General Permit), the SWPPP is also intended to outline the steps an operator must take to comply with the VAR10 GP. The SWPPP can include, or incorporate by reference, the ESC, SWM, SPCC, and any other applicable plans in order to fulfill the requirements of the VAR10 GP.

In addition to the procedures listed above, the SWPPP must also address the following procedure when VAR10 GP coverage is required:

- Implementation of the SWPPP from commencement of land disturbance until termination of coverage under the VAR10 GP.

For select projects (see Section II.A), the site-specific SWPPP will be submitted to the VADEQ for review.

Although only some parts of 9VAC25-880 have been included verbatim within this section of the Annual Standards, the VADEQ requires all components of 9VAC25-880 to be followed.

D. VAR10 General Permit

The VADEQ cannot require coverage under VAR10 GP for construction, operation, or maintenance of *transmission* pipelines or appurtenant facilities (e.g., compressor stations, metering stations, valve settings, etc.), or associated features (e.g., access roads); this applies to large/high profile *transmission* projects as well. VAR10 GP coverage would still be applicable for any non-transmission (i.e., distribution) gas projects. Refer to 9VAC25-870-380.A.2. for the entire definition of instances where the VADEQ cannot require VAR10 GP coverage.

For any projects subject to VAR10 GP (i.e., non-transmission projects), coverage is required if one or more acres of land will be disturbed, regardless of the size of the individually owned or developed sites. Projects filing for VAR10 GP coverage shall submit a **Registration Statement** to the VADEQ. A copy of the Registration Statement can be found on the Construction General Permit page of the VADEQ website. The following land-disturbing activities are covered by the VAR10 GP:

- Construction activities resulting in land disturbance equal to or greater than one acre;

- Construction activities resulting in land disturbance less than one acre that are part of a larger common plan of development or sale that ultimately disturbs one or more acres. A larger common plan of development or sale is a contiguous area where separate and distinct construction activities may be taking place at different times on different schedules; and

- Stormwater discharges from support activities (e.g., concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas) located on site or off site provided that:

    - The support activity is directly related to the construction activity that is required to have the VAR10 GP;

    - The support activity is not a commercial operation, nor does it serve multiple unrelated construction activities by different operators;

- The support activity does not operate beyond the completion of the last construction activity it supports;

- The support activity is identified in the Registration Statement at the time of application for VAR10 GP coverage;

- Appropriate control measures are identified in a SWPPP and implemented to address the discharges from the support activity areas; and

- All applicable state, federal, and local approvals are obtained for the support activity.

If a project is subject to VAR10 GP coverage (i.e., non-transmission projects) and will not result in significant changes to the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization, TC Energy can submit a Decline to Permit letter under GM 15-2003 to the VADEQ specifically requesting that VADEQ waive coverage under the VAR10 GP. Projects filing a Decline to Permit letter shall submit a Registration Statement alongside the site-specific ESC Plan and water quantity calculations. Upon reviewing the transmittal letter, the VADEQ can waive the requirement to obtain coverage under the VAR10 GP if non-significance is determined. The VADEQ will review projects on an individual basis. The VADEQ may also request an analysis of water quality.

TC Energy can file a Decline to Permit letter as long as the following conditions are met and incorporated into the site-specific ESC Plan:

- The project does not significantly alter the predevelopment runoff characteristics after the completion of construction and final stabilization;

- Less than one (1) acre of land disturbance occurs on a daily basis;

- Disturbed land where work has been completed is adequately stabilized on a daily basis;

- The environment is protected from erosion and sedimentation damage associated with the land-disturbing activity;

- The owner and/or construction activity operator designs, installs, implements, and maintains pollution prevention measures to:

    - Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters;

    - Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on site to precipitation and to stormwater;

- Minimize the discharge of pollutants from spills and leaks and implement chemical spill and leak prevention and response procedures;

- Prohibit the discharge of wastewater from a concrete washout;

- Prohibit the discharge of wastewater from the washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials; and

- Prohibit the discharge of fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance.

• The owner and/or construction activity operator provides reasonable assurance to VADEQ or the local VSMP authority that all of the above conditions will be satisfied.

A Decline to Permit letter does not have to be submitted for a transmission gas project, as VADEQ cannot require VAR10 GP coverage for transmission projects.

E. Non-Linear Project (and select Large/High Profile Project) Permitting

Non-linear projects, even those covered under the Annual Standards (i.e., non-linear projects essential to the installation, operation, or maintenance of a linear project), require additional permitting as TC Energy can only apply for waivers under GM 15-2003 for linear projects.

Depending on the size of the land disturbance for a project, different site-specific plans will need to be developed prior to construction: an ESC Plan for sites disturbing greater than or equal to 10,000 square feet; a SWM Plan for sites disturbing greater than or equal to one acre; and a SWPPP for sites disturbing greater than or equal to one acre.

For projects within designated CBPAs (see Section II.J), the threshold area of land disturbance required to develop an ESC or SWM Plan is reduced to 2,500 square feet. The Annual Standards may be used as a guidance document in developing these plans, but the other VADEQ regulations listed in II.B and any local regulations also need to be reviewed and incorporated.

In addition, coverage under the VAR10 GP may be required for sites disturbing greater than or equal to one acre. The conditions when VAR10 GP coverage is required are described in Section II.D.

Select projects may also have additional permitting requirements. VADEQ will determine on a case-by-case basis which projects are to be permitted in this manner, but they will typically be “large” or “high profile” projects (see Section II.A). For these projects, TC Energy will submit the ESC Plan, SWM Plan, and SWPPP (as applicable depending on the area of disturbance) to the VADEQ for approval. These select projects will also be subject to additional reporting requirements as described in Section III.D.

F. Applicable Regulatory Authority

For projects covered under the Annual Standards, VADEQ is the VESCP/VSMP Authority as the work is conducted under these VADEQ-approved Annual Standards and a site-specific ESC Plan. Submittal of site-specific ESC Plans and SWM Plans to local regulatory agencies is not required.

For project work not covered under the Annual Standards, if the locality is its own VSMP authority, rather than the VADEQ, then the VAR10 GP Registration Statements (see VAR10 GP applicability in Section II.D), notices of termination, and transfer of ownership agreements are to be submitted to the local VSMP authority where the land-disturbing activity occurs. Project plans shall comply with any local VESCP and VSMP authority’s technical requirements adopted in accordance with ESC Law and the SWM Act. If the locality has deferred VSMP authority to the VADEQ, then the above forms shall be submitted to the VADEQ. Refer to the latest version of the VSMP Authority map on VADEQ’s website to determine if a local authority has jurisdiction. When necessary, TC Energy may need to demonstrate that the local VESCP and/or VSMP authority’s technical requirements are not practicable for a project under consideration. The current VSMP Authority map, as of the date of this printing, is also provided in Appendix F.

G. Plan Review

All site-specific ESC plans and SWM plans are prepared by qualified consultants and shall undergo an internal TC Energy review process. This review may be conducted by TC Energy’s Environmental Permitting or Environmental Program Compliance Group representative or a qualified consultant; only certified **Plan Reviewers** will be allowed to review these plans; see Section III.B or IV for certification requirements. If the review is conducted by a qualified consultant, the Plan Reviewer must be different than the person who prepared the plan(s). The name and title of the Plan Reviewer must be stated within the plan(s) (e.g., on a signature/certification page).

By reviewing the plans, the Plan Reviewer is verifying that the plan(s) address all applicable regulations listed in Section II.B, the VESCH, the Virginia Stormwater Management Handbook, other VADEQ technical documents, and local regulatory criteria. In addition, the project’s construction team reviews the plan(s) for potential construction-related implementation issues.

TC Energy shall document plan approval by having an ESC **Program Administrator** and SWM Program Administrator review the stamped ESC/SWM plans and applicable checklist (Appendices D and E). The Program Administrators will then certify a statement on TC Energy letterhead that the plan and checklist have been prepared and are in accordance with the Virginia ESC and SWM regulations. The date of the approvable plan will be documented on an approval letter. The Program Administrators must be TC Energy employees.

In addition to TC Energy's internal review process by a Plan Reviewer, site-specific plans *may*, at VADEQ's discretion, need to be submitted to VADEQ or the local VSMP authority for review. If TC Energy files a SWM Plan waiver or Decline to Permit letter, the site-specific ESC Plan needs to be submitted to VADEQ. If a project is "large" or "high profile" (see Section II.A), the following site-specific plans need to be submitted to the VADEQ for review: ESC Plan, SWM Plan, and SWPPP.

H. Permit Modifications/Documenting On-Site Changes

The site-specific plan(s) and SWPPP (if required) shall be amended whenever there is a change in design, construction, operation, or maintenance that has a significant effect on discharge of pollutants to surface waters, or if, during an inspection by local, state, federal, or TC Energy personnel, it is determined that existing control measures are ineffective at minimizing pollutants in stormwater discharges. All updates shall occur no later than seven days following modifications to its implementation.

In compliance with §62.1-44.15:55 of the Virginia Erosion and Sediment Control Law, on-site changes may occur when adequate documentation of the changes is provided in the individual site-specific plan(s) and SWPPP (if required). Personnel who are allowed to make changes will be delegated by TC Energy; at a minimum, the **Responsible Land Disturber (RLD)** and **Environmental Inspector (EI)** will be allowed to make minor "redlined" field adjustments. During construction, ESC/SWM Plan redlines must be checked and signed off on by the appropriate **Certified Inspector** (**ESC** and/or **SWM Inspectors**).

Major modifications may require formal approval by VADEQ and should be verified with the agency prior to proceeding; major modifications may include, but are not limited to, changes in the information provided on the Registration Statement (see Section II.C), an increase in the disturbed area, or significant alteration of the proposed drainage patterns that would change the method of compliance for the water quality or quantity requirements. Major modifications require submittal to the ESC/SWM Plan certified Plan Reviewer, where they will be reviewed, reapproved, documented, and dated on the plans.

Movement of site or trench spoils shall be documented in daily field reports. If the need arises to move spoils off site, a record describing the disposal will be prepared and kept with the SWPPP. The record will include such items as the name and permit information of the off-site disposal facility, estimated volume to be moved, and any other relevant information to properly document the spoil movement (e.g., items from the daily field report). TC Energy’s Environmental Services group should be consulted for approved disposal facilities.

I. Variances

Modifying or waiving any of the ESC regulations, including any MS in 9VAC25-840-40, requires submission of a written Variance Request to VADEQ for review and approval. Variance Requests will be considered on a project-specific basis; a typical variance request might be to allow more than 500 feet of trench exposed at one time, which deviates from MS-16. An ESC Plan must be submitted with the Variance Request. The names and contact information for the Certified Inspectors (ESC and SWM Inspectors) and RLD are required with a Variance Request. If the name(s) of the inspectors and/or RLD are unknown at the time of the Variance Request, then a statement providing assurance that the information will be included with the two-week notification (see Section III.D) can suffice. At a minimum, the following information shall be included in variance requests:

- Introduction;
- Project Description;
- MS Variance Requests;
- Existing Conditions and Adjacent Areas;
- Soil Characterization;
- Critical and Sensitive Areas (e.g., Karst geology, wetland, etc.);
- Mitigation Procedures and Practices;
    - ESC Measures;
    - Permanent Stabilization;
    - Vegetative Restoration;
    - Maintenance;
    - Critical and Sensitive Areas; and
- Self-Inspection, Reporting, and VADEQ-Certified Personnel.

The VADEQ shall respond in writing either approving or disapproving the Variance Request. In accordance with 9VAC25-840-50, if the VADEQ does not approve a variance within 10 days following receipt of the request, the request shall be considered disapproved, unless otherwise state/documented by the VADEQ.

Following disapproval, a new Variance Request with additional documentation may be resubmitted.

Any proposed variance from the Annual Standards will require approval from VADEQ and from TC Energy's Environmental Permitting Group prior to commencing the activity. The VADEQ shall respond in writing either approving or disapproving the Variance Request.

Depending on the nature of the variance, the Environmental Permitting Group may be required to obtain written approval from the Director of the **Federal Energy Regulatory Commission (FERC)** Office of Energy Projects, or his/her designee.

Although incorporation of the details and specifications from the VESCH is strongly preferred, it is permissible to use non-VESCH and proprietary best management practices, provided that they are further reviewed and approved by VADEQ on a project-specific basis. The following information will be included for these proprietary practices: product manufacturer, appropriate design storm, inspection frequency, maintenance, and other applicable product information. Details on the proprietary practices shall be included within each site-specific SWPPP for SWM regulations, if applicable.

Non-VESCH and proprietary control measures shall be installed per the manufacturer's instructions and with the intent of the VESCH specifications. If non-VESCH control measures fail to effectively control soil erosion, sediment deposition, and non-agricultural runoff, VESCH control measures shall be utilized.

Refer to the ECS in Appendix A for additional details on the measures and methods to be implemented to minimize potential for pollution from construction activities.

Unapproved variances from an EMCP and the Annual Standards are not permitted.

J. Chesapeake Bay Preservation Area

CBPAs are zones of unique habitat or environmental resources that are designated by local authorities to require additional protection. These areas can include a 100-foot buffer around tidal shores, tidal wetlands, non-tidal wetlands contiguous to tidal wetlands, and non-tidal wetlands contiguous to bodies of water with perennial flow. Coordination with local governments to identify CBPAs may be required.

In accordance with the Virginia Erosion and Sediment Control Law and Regulations, any project that occurs within a CBPA and equals or exceeds 2,500 square feet of land disturbance will require a site-specific ESC and SWM Plan; a SWM Plan waiver package can still be applied for within a CBPA (see Section II.C). These projects also require a VADEQ-certified RLD to oversee proper implementation of the ESC Plan. See Sections II.C for the site-specific ESC and SWM Plan requirements.

K. Environmental Management and Construction Plans

The Annual Standards shall be used as the base document from which TC Energy will develop a site-specific EMCP as called for in TC Energy's policies, in addition to the project's ESC Plan and SWM Plan. The EMCP is a general construction document that includes or references all applicable environmental-related permits and documents. In addition, the EMCP summarizes environmental requirements for the project to facilitate proper and timely implementation.

For those projects requiring site-specific ESC and/or SWM plans, the EMCP will include those plans along with the ECS (only need to reference to the Annual Standards), as agreed to by the VADEQ.

III. Construction Administration

ESC and SWM administration, plan design, review, and approval, and construction inspection and enforcement will be conducted in compliance with the approved Annual Standards and all referenced laws, regulations, handbooks, and technical bulletins. Certified Program Administrators, Certified Plan Reviewers, and Certified Inspectors, and other personnel as needed, will be utilized to accomplish this task. An EI may fill the role of the ESC Inspector and/or the SWM Inspector as long as all the certification requirements have been met (see Section IV). Refer to Section VI.B of the ECS in Appendix A for a full list of EI responsibilities.

TC Energy may enter into agreements or contracts with contractors to assist with carrying out the certification requirements referenced in the Annual Standards, SWM Act, ESC Law, and other applicable regulations.

A. Inspections

A VADEQ-certified RLD will be named for each regulated land-disturbing activity prior to initiating land disturbance. The Certified Inspectors and the RLD are responsible for confirming that the construction activity is performed in accordance with the environmental conditions of the EMCP and landowner requirements, and have the authority to stop work and order appropriate corrective action as outlined in Section VI.B of the ECS in Appendix A.

For projects with an assigned EI, the EI will report to the TC Energy employee in responsible charge. For construction activities that are found by the Environmental Program Compliance Group to have minimal environmental impacts, the EI may also serve to monitor other construction functions. EIs shall have peer status with all other activity inspectors.

Periodic ESC and SWM inspections should ensure compliance with the Annual Standards and the ESC and SWM regulations. Inspection reports should document onsite changes by noting issues of non-compliance. Corrective actions should be called out on inspection reports and include timeframes for completion.

Periodic ESC inspections shall be conducted for projects that are greater than or equal to 10,000 square feet (or greater than or equal to 2,500 square feet in CBPAs). The ESC Inspector shall provide for and document inspections at the following frequency: during or **immediately** following initial installation of ESC devices, at least once in every two-week period, within 48 hours following a runoff-producing storm event, and at the completion of the project prior to release of any performance bonds. Inspections may be conducted at a greater frequency upon recommendation by the RLD and/or VADEQ (e.g., if there are sensitive features close to the active construction area, or during the winter).

Periodic SWM inspections shall be conducted for projects that are greater than or equal to 1 acre (or greater than or equal to 2,500 square feet in CBPAs). The SWM

Inspector shall inspect for SWM compliance at the beginning of the project, monthly, and as needed periodically throughout the project. Additionally, the SWM Inspector shall periodically (minimum quarterly) inspect the installation and function of stormwater management measures. Inspections may be conducted at a greater frequency upon recommendation by the RLD and/or VADEQ (e.g., if there are sensitive features close to the active construction area, or during the winter). SWM inspections shall review the project for:

- Compliance with the approved ESC Plan;
- Compliance with the approved SWM Plan;
- Development and implementation of a pollution prevention plan, updating it as necessary; and
- Development and implementation of any additional control measures necessary to address a TMDL.

For projects requiring a SWPPP (i.e., projects that are greater than or equal to 1 acre), SWPPPs will be inspected at the beginning of the project and periodically (minimum monthly) throughout, including the development, updating, and implementation of a pollution prevention plan. The ESC Inspector shall conduct inspections at the following frequency: at least once every five business days, or at least once every ten business days and within 24 hours following a runoff-producing storm event. The inspection frequency may be reduced to once per month in areas that have been temporarily stabilized, or land disturbing activities will be suspended due to continuous frozen ground conditions and stormwater discharges are unlikely. If weather conditions (e.g., above-freezing temperatures, or rain or snow events) would make discharges likely, the ESC Inspector will resume the typical inspection frequency. For projects discharging to exceptional waters, impaired waters, and/or waters with approved TMDLs, the ESC Inspector shall conduct inspections at the following frequency: at least once every four business days; or at least once every five business days and within 24 hours following a runoff-producing storm event. Refer to 9VAC25-880 for the complete list of SWPPP inspection requirements.

For projects that are regulated under the FERC, temporary erosion control measures shall, at a minimum, be inspected at the following frequency: on a daily basis in areas of active construction or equipment operation, on a weekly basis in areas with no construction or equipment operation, and within 24 hours of each 0.5 inch of rainfall.

TC energy will maintain a level of oversight of the project by Certified Inspectors. If a project is subject to several of the ESC inspection requirements above, the ESC Inspector will conduct the most stringent inspection frequency. The Certified Inspector conducting the periodic ESC and SWM inspections may be the same individual (e.g., the EI) so long as they hold both ESC and SWM Inspector certifications (see Section IV). Responsibilities for RLD and SWPPP may also be combined but are separate from the periodic oversight inspections.

B. Training/Qualifications

The RLD shall have already obtained an RLD Certificate through the VADEQ Certification and Tracking System prior to conducting oversight operations. The RLD may be a TC Energy employee or a third-party individual.

The ESC and SWM Inspectors shall have already obtained certification from the VADEQ Erosion and Sediment Control or Stormwater Management Inspector Certification training when conducting ESC and SWM inspections, respectively. The EI shall have also obtained these certifications if conducting ESC and SWM inspections. The Certified Inspectors and EI may be TC Energy employees or third-party personnel.

The construction manager or operations team leader assigned to the construction activity will be responsible for verifying that the EI(s), other inspectors, and any contractor's foreperson have been trained in all environmental aspects of the activity, and fully understand the environmental conditions contained in the activity's EMCP. The construction manager and operations team leader may be TC Energy employees or third-party personnel.

The Plan Reviewers shall have already obtained certification from the VADEQ Erosion and Sediment Control or Stormwater Management Plan Reviewer Certification training when performing ESC Plan and SWM Plan reviews, respectively. Virginia certified professionals (i.e., professional engineers, architects, landscape architects, land surveyors, and soil scientists) are exempt from the ESC Plan reviewer certification course requirement; these professionals must still take the SWM Plan reviewer course, however. The certified Plan Reviewers may be TC Energy employees or third-party personnel.

The Program Administrators shall have already obtained certification from the VADEQ Erosion and Sediment Control or Stormwater Management Program Administrator Certification training prior to conducting ESC or SWM administrative duties, respectively. The certified Program Administrators must be TC Energy employees.

TC Energy's Environmental Permitting Group and/or Environmental Compliance Program staff will conduct training for construction personnel prior to construction when sensitive resource issues are present, when permit/certificate conditions mandate, or when otherwise requested or deemed necessary.

C. Virginia Department of Environmental Quality Inspections

VADEQ may perform random site inspections or inspections in response to a complaint to confirm compliance with the Annual Standards and applicable federal, state, and local regulations. VADEQ also has authority to enforce approved specifications and take enforcement actions when necessary.

VADEQ can charge fees for oversight activities equal to the lower of the two following amounts: $1,000, or an amount sufficient to cover costs associated with standard and specification review and approval, projection inspections, and compliance. These associated costs may include VADEQ plan review and inspection.

D. Reporting

Varying levels of reporting are required based on the size of a project; as stated in Section II.E, large projects are subject to additional reporting requirements compared to standard projects. However, prior to initiating a regulated land disturbance activity of any size, electronic notification (e.g., email) is required to be submitted to VADEQ two weeks (14 days) before initiating the activity. Email the two-week notification to standardsandspecs@deq.virginia.gov. The following information shall be included in the electronic notification:

- Project name or project number;
- Project location (including nearest intersection, latitude and longitude);
- On-site project manager name and contact information;
- EI name and contact information;
- RLD name and contact information;
- Project description;
- Project disturbance acreage;
- Project access point;
- Project start and finish dates; and
- Any variances/exemptions/waivers associated with the project.

For all regulated land-disturbing activities, project tracking reports shall be submitted to the VADEQ on an annual basis, due on December 31. These tracking reports shall contain the same information required for the electronic notification (see the bulleted list above) and can be submitted electronically to standardsandspecs@deq.virginia.gov; Excel spreadsheets are an acceptable submission format.

For Section 7b and Section 7c projects, status reports must be filed with the FERC documenting the results of follow-up inspections; any problem areas, including those identified by the landowner; and corrective actions taken for at least two years following construction. This does not apply to project construction under automatic authorization, prior notice, or advanced notification provisions in the FERC regulations.

Site-specific plans for large projects may, at VADEQ's discretion, need to be posted for public review and approval on a website managed by TC Energy. In addition, if the project is covered under the VAR10 GP, the operator shall post the notice of coverage letter at a publicly accessible location near an active part of the construction project (e.g., where a pipeline crosses a public road), and maintain the posting until coverage under the VAR10 GP is terminated.

For large projects, the following information may (at VADEQ's discretion) need to be submitted as part of the weekly electronic reporting to the regional VADEQ office:

- Inspection reports;
- Photographs;
- Complaint logs and complaint responses; and
- Other compliance documents.

E. Long-Term Operation and Maintenance

When SWM control devices or other techniques are required for regulated land-disturbing activities, the individual site-specific plans (e.g., construction drawings/sheets and narrative) will contain adequate information to provide for the long-term responsibility and maintenance of the required SWM control devices or other techniques.

Follow-up inspections must be conducted of all disturbed areas, as necessary, to determine the success of revegetation and address landowner concerns; at a minimum, follow-up inspections must be conducted after the first and second growing seasons. If revegetation is unsuccessful, revegetation efforts must be continued until the **restoration** ground cover is uniform, mature enough to survive, and will inhibit erosion.

VADEQ, as the VSMP authority, requires provisions for long-term responsibility for, and maintenance of, SWM facilities and other measures designed to manage runoff quality and quantity as presented in the SWM Plan or SWPPP. These provisions will be set forth in an instrument recorded in the local land records prior to VAR10 GP termination, project completion (for projects that do not need VAR10 GP coverage), or earlier as required by the VSMP authority. At a minimum, these provisions shall:

- Be submitted to TC Energy, as the Annual Standards holder, for approval prior to approval of the SWM Plan;

- Be stated to run with the land;
- Provide all necessary access to the property for maintenance and regulatory inspections;
- Provide for submitting inspection and maintenance reports to the VSMP authority; and
- Be enforceable by all appropriate agencies.

F. Recordkeeping

Project records, including approved ESC plans, SWM plans, and/or SWPPPs shall be retained for three years after state permit termination or project completion. Construction record drawings shall be maintained in perpetuity or until a SWM facility is removed. All Registration Statements applying for state permit coverage submitted for the VAR10 GP shall be documented and retained for at least three years after state permit termination or project completion.

ESC site inspection and SWM facility inspection records shall be retained for at least five years from the date of inspection. The inspection records shall be extended beyond five years during any unresolved litigation and may be extended upon request by VADEQ.

In accordance with 9VAC25-840-90.A.3., a copy of the approved plan and a record of inspections for each active land-disturbing activity shall be maintained either on-site or in the Annual Standards files.

All project documents, including amendments, modifications, updates, and the SWPPP, shall be made available upon request by VADEQ, the Environmental Protection Agency, the public, or an operator for a municipal separate storm sewer system that receives discharges from the construction activity. These documents may, at VADEQ's discretion, need to be posted electronically for public review.

IV. Definition of Terms

ANNUAL STANDARDS: Annual Standards and Specifications for Erosion & Sediment Control and Stormwater Management.

APPURTENANT FACILITIES: ancillary or support facilities required for the installation, maintenance, and/or operation of a linear gas utility; includes, but is not limited to, well locations, compressor stations, metering/regulation stations, access roads, valves, drips, and cathodic protection equipment.

CBPA: Chesapeake Bay Preservation Area.

CERTIFIED INSPECTORS: Virginia Department of Environmental Quality-certified Erosion and Sediment Control and Stormwater Management Inspectors (see ESC INSPECTOR and SWM INSPECTOR definitions).

COLUMBIA: Columbia Gas Transmission, LLC.

COMBINED ADMINISTRATOR: A Combined Administrator has taken all three of the appropriate Erosion and Sediment Control or Stormwater Management Virginia Department of Environmental Quality training courses (i.e., Inspector, Reviewer, and Administrator), and may fulfill any of the applicable Erosion and Sediment Control or Stormwater Management duties and responsibilities (see CERTIFIED INSPECTORS, PLAN REVIEWER, and PROGRAM ADMINISTRATOR definitions for details on their respective duties).

CWA: Construction work area; includes permanent and temporary right-of-way, contractor's yards, pipe and materials storage yards, and access roads.

ECS: Environmental Construction Standards.

EI: Environmental Inspector; responsible for environmental compliance on a construction project. The Environmental Inspector may fill in the roles of the ESC and SWM Inspectors, provided that the appropriate certifications have been met (see ESC INSPECTOR and SWM INSPECTOR definitions).

EMCP: Environmental Management and Construction Plan; general construction document that includes the following: project-specific description, project-specific environmental highlights, all environmental permits as attachments (and written summary of all permits), ESC Plan as an attachment (if required), SWM Plan as an attachment, Environmental Construction Standards as an attachment, the Project Determination & Information Form. The EMCP may substitute for a separate SWPPP document, provided that the EMCP satisfies all the required components of a SWPPP. For projects where this occurs, additional text shall be included within the EMCP narrative identifying the substitution and where the required components of the SWPPP are located within the EMCP, and that the EMCP is required to be on site during construction and available for inspection by VADEQ.

EMERGENCY PROJECT (ESC DEFINITION): Projects that will be conducted when there is an immediate need of repair in order to protect life, limb, property, or the environment and will include land disturbance (ESC). Emergency projects will be conducted in accordance with the Annual Standards and the disturbed land area shall be shaped and stabilized in accordance with the requirements of the VADEQ (or VESCP authority for non-applicable projects). If required based on project acreage, the Erosion and Sediment Control Plan may be developed after the project has already commenced (i.e., retroactively). The VADEQ (or VESCP authority for non-applicable projects) should be electronically notified as soon as possible upon commencing the land-disturbing activity. See LAND DISTURBANCE (ESC DEFINITION) for the definition of land disturbance as it relates to erosion and sediment control. Refer to Code of Virginia § 62.1-44.15:51 for additional information on emergency projects as they relate to ESC.

EMERGENCY PROJECT (SWM DEFINITION): Projects that will be conducted when there is an immediate need of repair in order to protect life, limb, property, or the environment and will include land disturbance (SWM). Emergency projects will be conducted in accordance with the Annual Standards. If required based on project acreage, the Stormwater Management Plan may be developed after the project has already commenced (i.e., retroactively), but it shall be developed within 30 days of commencing the land-disturbing activity. The VADEQ (or VSMP authority for non-applicable projects) shall be electronically notified within seven days of commencing the land-disturbing activity. See LAND DISTURBANCE (SWM DEFINITION) for the definition of land disturbance as it relates to stormwater management. Refer to Code of Virginia § 62.1-44.15:34 for additional information on emergency projects as they relate to SWM.

ESC: Erosion and sediment control.

ESC INSPECTOR: Erosion and Sediment Control Inspector; responsible for periodically examining the erosion and sediment control and land disturbance activities for compliance with applicable regulations. Completion of the Virginia Department of Environmental Quality Inspector for Erosion and Sediment Control training course and passing the certification exam is required to inspect erosion and sediment control devices.

ESC PLAN: Erosion and Sediment Control Plan; unlike the Environmental Management and Construction Plan, the Erosion and Sediment Control Plan includes details on erosion and sediment control specifications and complying with applicable erosion and sediment control regulations.

EXCEPTIONAL STATE WATER: A stream or waterbody that constitutes an outstanding national, state, regional, or local resource, such as waters of national, state, or county parks or forests; waters that are used as a source of unfiltered potable water supply; waters of wildlife refuges or state game lands; waters that have been characterized by the Fish Commission as "Wilderness Trout Streams"; and other waters of substantial recreational or ecological significance. May also be referred to as Tier III Waters.

EXTRA WORK AREA: An area included within the construction work area that is needed in addition to the minimum area required for construction activities. Extra work areas typically include additional temporary workspaces or staging areas at railroad, waterbody, or wetland crossings; areas with steep slopes or where blasting is required; or areas at the beginning or end of a pipeline segment for mobilization/demobilization. Because extra work areas are within the construction work area, they are, at a minimum, permitted and protected in the same manner as the construction work area as described in the Annual Standards and the Environmental Construction Standards.

FERC: Federal Energy Regulatory Commission.

GM 15-2003: VADEQ's Guidance Memo No. 15-2003.

IMMEDIATE: Without interval of time; "right now."

LAND DISTURBANCE (ESC DEFINITION): Manmade change to the land surface that may result in soil erosion from water or wind and the movement of sediments into state waters or onto lands in the Commonwealth, including, but not limited to, clearing, grading, excavating, transporting, and filling of land. Use this definition when referring to land disturbance related to Virginia erosion and sediment control regulations. See LAND DISTURBANCE (SWM DEFINITION) for the definition of land disturbance as it relates to stormwater management.

LAND DISTURBANCE (SWM DEFINITION): Manmade change to the land surface that potentially changes runoff characteristics, including, but not limited to, clearing, grading, or excavation. Use this definition when referring to land disturbance related to Virginia stormwater management regulations. See LAND DISTURBANCE (ESC DEFINITION) for the definition of land disturbance as it relates to erosion and sediment control.

LINEAR PROJECT: land-disturbing activity that is linear in nature, including, but not limited to, natural gas pipelines, electric and telephone utility lines, railroad track and associated facilities, highways, stormwater channels, stream restoration, water lines, and sewer lines.

MAINTENANCE ACTIVITY: Routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original construction of the project; maintenance activities include, but are not necessarily limited to, integrity digs (i.e., anomaly or leak repairs), cathodic protection/AC mitigation, right-of-way vegetation maintenance, pipeline inspections (day-lighting), slip repairs, exposure replacements, exposure removal, recoats, hydrotests, drips, wirelines, pig runs, aboveground appurtenance replacements, and minor maintenance on valves, taps, rectifiers, and access roads. Examples of minor maintenance include greasing valves, filling in potholes, and sandblasting and painting aboveground facilities for atmospheric corrosion protection. Class replacements or permanently transitioning a dirt road to a gravel or asphalt (impervious) road surface would *not* be considered a maintenance activity.

MS-X: Virginia 9VA25-840-40 Minimum Standards number XX (e.g., MS-1 refers to minimum standard 1).

PLAN REVIEWER: A certified individual who has a role in determining whether or not a prospective project will be in compliance applicable laws and regulations (e.g., Virginia Erosion and Sediment Control Law & Regulations). Completion of the Virginia Department of Environmental Quality Plan Reviewer for Erosion and Sediment Control training course is required in order to review Erosion and Sediment Control Plans; completion of the Virginia Department of Environmental Quality Plan Reviewer for Stormwater Management training course is required in order to review Stormwater Management Plans. Virginia certified professionals (i.e., professional engineers, architects, landscape architects, land surveyors, and soil scientists) are exempt from the Erosion and Sediment Control Plan reviewer certification course requirement.

POLLUTION PREVENTION PLAN: a component of the Stormwater Pollution Prevention Plan, the pollution prevention plan addresses potential pollutant-generating activities that may reasonably be expected to affect the quality of stormwater discharges from the construction activity, including any support activity; the pollution prevention plan shall: identify the pollutant-generating activities, expected pollutant, and location of the activities, identify all non-stormwater discharges that are or will be commingled with stormwater discharges from the construction activity, identify the person responsible for implementing pollution prevention practices, describe the pollution prevention practices and procedures, and describing procedures for providing pollution prevention awareness for all applicable wastes to personnel. Additional information on pollution prevention plans can be found in the General Virginia Pollutant Discharge Elimination System VAR10 General Permit for Discharges of Stormwater from Construction Activities.

PROGRAM ADMINISTRATOR: Program administrator means the person or persons responsible for administering and enforcing the Virginia Erosion and Sediment Control Program or Virginia Stormwater Management Program of a Virginia Erosion and Sediment Control Program authority or a Virginia Stormwater Management Program authority as may be applicable. Completion of the Virginia Department of Environmental Quality Program Administrator for Erosion and Sediment Control training course is required in order to accept erosion and sediment control administrative responsibilities; completion of the Virginia Department of Environmental Quality Program Administrator for Stormwater Management training course is required in order to accept stormwater management administrative responsibilities. In this document, 'Program Administrator' can refer to an Erosion and Sediment Control or Stormwater Management Program Administrator, depending on which is applicable.

RESTORATION: Includes fertilizing, liming, disking, seeding and mulching, and crimping mulch to establish a permanent vegetative cover. Final restoration with a permanent vegetative cover is considered as sufficiently established when ground cover is uniform, is mature enough to survive, and will inhibit erosion.

RLD: Responsible Land Disturber; individual (e.g., owner, applicant, permittee, designer, contractor, project manager, etc.) that is responsible for carrying out land disturbance in accordance with the approved Erosion and Sediment Control Plan. Requires obtaining a Responsible Land Disturber Certificate through the Virginia Department of Environmental

Quality Certification and Tracking System.

SPCC: Spill Prevention, Control, and Countermeasure Plan.

SUPPORT ACTIVITIES: Construction activity required for a project that may be located on or off site, including, but not limited to, activities in concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, and borrow areas (i.e., sources of imported fill). The Virginia Erosion and Sediment Control Program authority may consider off-site activities (including but not limited to borrow and disposal areas) as included in the proposed land-disturbing area (i.e., construction work area), or proof of approval that the off-site activity is already covered under an approved Erosion and Sediment Control Plan. On-site or off-site support activities stormwater discharges can be covered under the General Virginia Pollutant Discharge Elimination System VAR10 General Permit for Discharges of Stormwater from Construction Activities provided the conditions in 9VAC25-880-30 are met; off-site support activities may also be covered under another state or Virginia Pollutant Discharge Elimination System permit.

SWM: Stormwater management.

SWM INSPECTOR: Stormwater Management Inspector; responsible for periodically examining the stormwater management activities and land disturbance activities for compliance with applicable regulations. Completion of the Virginia Department of Environmental Quality Inspector for Stormwater Management training course and passing the certification exam is required to inspect stormwater management measures.

SWM Plan: Stormwater Management Plan; document describing methods for complying with the Virginia Stormwater Management Program that was established to manage the quality and quantity of runoff from land disturbance and includes local ordinances, rules, permits, specifications, technical materials, policies and guidelines, and requirements for review, inspection, enforcement, and evaluation.

SWPPP: Stormwater Pollution Prevention Plan; document prepared using good engineering practices that identifies potential sources of pollutants that could impact stormwater and the implementation of practices or measures to mitigate potential impacts, and incorporates or references an Erosion and Sediment Control Plan, Stormwater Management Plan, and a Pollution Prevention Plan.

TMDL: Total Maximum Daily Load; sum of point, nonpoint, background wasteload allocations for a specific constituent (e.g., sediment, aluminum, oil & grease) for a particular waterbody or series of waterbodies.

VADEQ: Virginia Department of Environmental Quality.

VAR10 GP: General Virginia Pollutant Discharge Elimination System VAR10 General Permit for Discharges of Stormwater from Construction Activities.

VESCH: Virginia Erosion and Sediment Control Handbook.

VESCP: Virginia Erosion and Sediment Control Program.

VPDES: Virginia Pollutant Discharge Elimination System.

VSMP: Virginia Stormwater Management Program; program established to manage runoff quality and quantity resulting from land disturbance activities and accounting for items such as local ordinances, rules, permit requirements, annual standards and specifications, policies and guidelines, technical materials, and requirements for plan review, inspection, enforcement, and evaluation.

WETLAND: An area of special concern that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support plants adapted to saturated soil conditions such as rushes, sedges, cattails, or certain trees. Typically includes swamps, marshes, bogs, and any area that satisfies the requirements of the current federal methodology for identifying and delineating wetlands.

*Includes all grammatical variations of each term.

APPENDIX A:
ENVIRONMENTAL CONSTRUCTION STANDARDS

VIRGINIA PROJECTS

November 2020

TC Energy

Table of Contents

I. Introduction

As stated in the **Annual Standards and Specifications for Erosion & Sediment Control and Stormwater Management (Annual Standards)**, this **Environmental Construction Standards (ECS)** document provides additional details on the methods and practices to be implemented in order to conduct **TC Energy** construction activities in a manner that minimizes erosion and enhances revegetation. This document is applicable to all TC Energy wholly or partially owned subsidiaries, including **Columbia Gas Transmission, LLC (Columbia)**.

II. Upland Construction

A. General

The typical upland pipeline construction spread operates as a moving assembly line in which specialized procedures are performed in an efficient, planned sequence. Figure 1 presents a typical upland pipeline construction sequence. In addition, special construction crews install and alter fences, bore under roads and railroads, install stream and **wetland** crossings in accordance with Section III, conduct **horizontal directional drilling (HDD)**, and construct valve settings and meter/regulator stations.

While construction work is ongoing, the **construction work area (CWA)** will be kept clean of all rubbish and debris resulting from the work. Excess construction materials and debris will be collected, contained, and disposed of at regular intervals throughout the construction process. Frequency of disposal will vary depending on the project, but typically containers will be disposed of when they are filled; a supply of excess debris/waste storage containers will be available on-site to ensure there are no unmanaged waste piles. Construction wastes and debris includes timber mats, garbage, as well as drill cuttings and fluids. Non-hazardous materials and waste shall be disposed of in an approved landfill. Hazardous waste shall be disposed of in accordance with TC Energy policies and federal, state, and local regulations.

B. Right-of-Way Width

TC Energy typically utilizes a 50-foot-wide permanent **right-of-way (ROW)** plus a 25-foot-wide temporary construction ROW (as illustrated on Figure 2). After the CWA is restored, the temporary work areas are allowed to revert to their previous uses. The permanent ROW is maintained by TC Energy. Figure 3 illustrates the typical pipeline CWA when paralleling existing facilities.

Additionally, there may be instances where **extra work areas** are needed for topsoil conservation (Figure 27), side hill construction (Figure 7), equipment staging, pipe and material storage, borrow and disposal areas, temporary and permanent access, and related construction activities. Such areas will be identified in the project plans and will undergo all required environmental and cultural resources reviews prior to use. In contrast, pipelines may be constructed through confined areas such as extremely steep and narrow ridges. Alternate construction methods may be required in narrow CWA situations to safeguard workers, equipment, the pipeline, and the environment.

For non-linear construction activities, such as storage well and station projects, the CWA and permanent ROW may vary and can be dependent on property lease, property owner agreements, and/or local topography. For example, the CWA for a typical storage well is 200 feet by 200 feet and the permanent ROW is a 300-foot radius around the well.

All project-related ground disturbance shall be limited to the CWA, which includes extra workspace areas, pipe storage yards, borrow and disposal areas, access roads, and other areas approved in the **Federal Energy Regulatory Commission's (FERC's)** Orders, and/or other federal/state/local environmental permits. This does not apply to activities needed to comply with the FERC Plan and Procedures (i.e., slope breakers, energy-dissipating devices, dewatering structures, drain tile system repairs) or minor field realignments and workspace shifts per landowner needs and requirements that do not affect other landowners or sensitive environmental resource areas. All construction or restoration activities that may occur outside of the approved limit of disturbance detailed in the **Environmental Management and Construction Plan (EMCP)** and **Erosion and Sediment Control (ESC) Plan** are subject to all applicable survey and permit requirements, as well as landowner easement agreements, and must be approved by TC Energy's Environmental Permitting Group and/or the **Virginia Department of Environmental Quality (VADEQ)** prior to that activity occurring. Applicable surveys include all environmental and regulatory mandated surveys such as, but not limited to: threatened and endangered species surveys, archaeology surveys, and wetland delineations.

In addition to the extra work areas, on- or off-site **support activities** may be needed to complete construction operations; support activity areas can include concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, and borrow areas (i.e., sources of imported fill). For off-site support activities (including but not limited to borrow and disposal areas), the **Virginia Erosion and Sediment Control Program (VESCP)** authority may consider the off-site activity as being part of the proposed land-disturbing activity; or, if the off-site activity is already covered by an approved ESC Plan, the VESCP authority may require the applicant to provide proof of the approval and to certify that the plan will be implemented in accordance with applicable federal, state, and local regulations.

Stormwater discharges from off-site support activities may also be covered under another state or **Virginia Pollutant Discharge Elimination System (VPDES)** permit. In this case, the land area of the off-site support activity will not need to be included within the total **land disturbance** acreage of the construction project.

C. Clearing

The CWA will be cleared to the width specified in the ROW agreements or EMCP, whichever is less. All brush and trees should be felled into the CWA to prevent damage to trees and structures outside of the CWA.

The clearing crew and related equipment necessary for installation of temporary stream crossings will be permitted a single pass through streams prior to installing the temporary vehicular equipment crossing. The number of **waterbody** crossings will be limited to one per piece of clearing equipment, unless the stream is designated as an **exceptional state water**. In accordance with **Virginia 9VAC25-840-40 Minimum Standards 13 (MS-13)**, included in Attachment B, if a live waterbody must be crossed by construction vehicles more than twice in any six-month period, a temporary stream crossing shall be installed as described in Section III. This requirement shall be superseded by federal, state, and local agencies that have more stringent regulations.

In accordance with MS-4 in Attachment B, temporary sediment control devices (e.g., sediment traps, perimeter dikes, and sediment barriers) shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place. Should substantial soil disturbance take place during clearing that is not adequately managed by the controls mentioned previously, TC Energy will install additional temporary erosion and sedimentation controls as described in Section II.D.3.

1. Wood Products

Wood products are the property of the landowner unless otherwise specified. They will not be used for any purpose unless permission is first obtained from the landowner. When the landowner requests salvage of these materials or approves wood products to be stockpiled and left on site, they will be stockpiled just off the edge of the CWA, but not within 50 feet of streams, floodplains, or wetlands. Equipment stacking the wood products will not leave the CWA. Usable timber that measures at least 10 inches in diameter at the butt will be cut into pole lengths (12 to 14 feet) or as otherwise negotiated with the landowner. Off-site disposal in other than commercially operated locations is subject to compliance with applicable environmental and cultural survey reviews, landowner approval, and applicable environmental permitting prior to disposal.

2. Brush

All cleared brush will be disposed of by one of the following methods:

- Brush may be piled just off the edge of the CWA, but not within 50 feet of streams, floodplains, or wetlands. Equipment stacking the brush will not leave the CWA. Brush piles will be constructed a maximum of 12 feet wide and be compacted to approximately 4 feet high, with periodic breaks at a minimum of every 200 feet to permit wildlife travel. Breaks should be no smaller than 4 feet wide to allow wildlife travel. Brush piles will be kept separate from usable timber and care will be taken to prevent mixing of soil and brush. The landowner should be consulted to determine acceptable brush pile locations along the CWA. Landowner approval is required for this method.

- Brush may be burned where permitted by law. The necessary burning permits will be obtained and are the responsibility of TC Energy's contractor to obtain. TC Energy must be provided with a copy of this permit prior to engaging in burning. Fires will be of reasonable size and located and patrolled so that they do not spread off the CWA.

- The brush may be chipped and buried or thinly spread (less than 2 inches thick) over the CWA or blown off the CWA (per landowner agreement) except in **agricultural lands** or within 50 feet of streams, floodplains, or wetlands. If woodchips are used as mulch, the application rate should be between 4 and 6 tons per acre, in accordance with **Virginia Erosion and Sediment Control Handbook (VESCH)** 3.35 Mulching, included in Attachment A (1 ton of chips spread 1-inch thick covers approximately 0.25 acre). Chipping will be limited to those areas agreed to with the landowner. During **restoration**, soil will be augmented by the addition of 12 pounds of nitrogen per ton of chips to aid revegetation, at least half of which must be slow release.

- Brush may be hauled off site. Off-site disposal in other than commercially operated locations is subject to compliance with applicable environmental and cultural survey reviews, landowner approval, and applicable environmental permitting prior to disposal.

3. Fence Crossings

Where it is necessary to remove fences, adequate temporary fences or gates as specified in VESCH 3.01 Safety Fence (Attachment A) and Figure 26 will be installed **immediately** or in accordance with landowner agreement. Such temporary fences or gates will be kept closed, except when necessary for construction purposes per landowner agreement. Once construction is completed, permanent fence repairs will be performed. Fences that have been cut or removed will be permanently repaired to match the original type of the fence as much as possible. When there is any doubt as to the usability of old fence material, new material will be used in making repairs. Fence repairs will be subject to the approval of the landowner.

D. Grading

Grading is necessary to provide a smooth and even surface for safe and efficient operation of construction equipment. Grading will be the minimum amount necessary and will include installation of ESC devices as a first step in land-disturbing activities and installation of equipment crossings at streams and wetlands. ESC devices shall be made functional before upslope land disturbance takes place in accordance with MS-4 (Attachment B).

1. Tree Stump and Rock Removal and Disposal

Tree stumps and large rocks will be cut, graded, or removed as necessary to permit construction and to provide adequate clearance for mechanical equipment and other vehicles. Tree stumps that are adjacent to roads will be cut close to the ground or removed.

Stumps and large rocks will be disposed of in one or a combination of the following methods, pending landowner approval:

- Buried within the CWA except in agricultural, residential, or wetland areas.
- Windrowed just off the edge of the CWA with landowners' permission.
    - Windrows will be a maximum of 12 feet wide with periodic breaks a minimum of 200 feet apart.
- Hauled from the site and disposed of in an approved landfill or other permitted area.

2. Topsoil Conservation

Unless the landowner or land management agency specifically approves otherwise, the mixing of topsoil with subsoil should be prevented by stripping topsoil from either the full work area or the trench and subsoil storage area (ditch plus soil side method) in cultivated or rotated croplands and managed pastures, residential areas, hayfields, and other areas at the landowner's or land managing agency's request.

Perimeter sediment control devices shall be in place prior to topsoil stripping in accordance with VESCH 3.30 Topsoiling (Attachment A). In deep soils (more than 12 inches of topsoil), at least 12 inches of topsoil shall be segregated. In soils with less than 12 inches of topsoil, every effort shall be made to segregate the entire topsoil layer. Segregated topsoil may not be used for padding the pipe, constructing temporary ROW diversions/slope breakers or trench line breakers, improving or maintaining roads, or as fill material. Figure 27 illustrates topsoil conservation techniques.

Segregated topsoil will be stockpiled separately from all subsoil throughout all construction activities and will be replaced last during **final grading**. Perimeter controls shall be placed around stockpiles immediately after formation, as necessary. Stockpiles shall be seeded within 7 days of formation if they are to remain dormant for longer than 14 days. The **Environmental Inspector (EI)** will determine if additional erosion control devices are needed in topsoil storage areas. Topsoil piles shall be stabilized and loss due to wind and water erosion minimized with the use of sediment control devices, mulch, temporary seeding, tackifiers, or functional equivalents, where necessary and/or required by environmental permits.

In residential areas, topsoil replacement (i.e., importation of topsoil) is an acceptable alternative to topsoil segregation, provided the topsoil comes from a commercial facility or a location that has been approved by the Environmental Permitting Group (for all applicable environmental permits and approvals) prior to importing topsoil.

Topsoil shall be stockpiled upslope of the trench, and shall be stabilized or protected with sediment trapping measures in accordance with MS-2 (Attachment B). Topsoil stockpiled downslope of the trench (e.g., when upslope stockpiling is not possible due to a ROW agreement, existing easement, or other circumstances) shall also be stabilized or protected with sediment trapping measures.

3. Erosion Control Devices (Installed Prior to Grading)

Temporary erosion controls will be installed and functional before land disturbance activities take place, in accordance with MS-4 (Attachment B). Temporary ROW diversions will be maintained during the construction phase until permanent diversions are installed. Where required grading has significantly reduced the slope, the EI may require fewer temporary ROW diversions consistent with the table shown in VESCH 3.11 Temporary Right-of-Way Diversion in Attachment A.

The outfall of each temporary ROW diversion shall be directed to a stable, well-vegetated area, or an energy-dissipating device (e.g., J-hook, compost filter sock, riprap outlet) shall be constructed at the end of the diversion and off the CWA; details regarding the design and installation of the energy-dissipating device examples listed above are included on Figure 11, Figure 11A, and in VESCH 3.18 Outlet Protection (Attachment A), respectively. The outfall of each temporary ROW diversion shall be positioned to prevent sediment discharge into wetlands, waterbodies, or other sensitive environmental resource areas. Temporary ROW diversions may extend slightly (approximately 4 feet) beyond the edge of the construction ROW to effectively drain water off the disturbed area if the appropriate state or local governing agency allows the extension.

Sediment barriers may also be necessary and are intended to stop the flow of sediments and to prevent the deposition of sediments beyond approved workspaces or into sensitive resources. At a minimum, temporary sediment barriers (e.g., silt fence, compost filter sock) shall be installed and maintained across the entire CWA at the base of slopes greater than 5 percent where the base of the slope is less than 50 feet from a waterbody, wetland, or road crossing until vegetation is successful. Adequate room must be provided between the base of the slope and the sediment barrier to accommodate ponding of water and sediment deposition. Where wetlands or waterbodies are adjacent to and downslope of CWAs, sediment barriers shall be installed along the edge of these areas, as necessary, to prevent sediment flow into the wetland or waterbody.

For silt fence installation, the bottom will be buried in a trench 4 inches deep and 4 inches wide, backfilled, and compacted with stakes placed a maximum of 6 feet apart (see VESCH 3.05 Silt Fence in Attachment A). Silt fence shall not be installed in areas of concentrated flow. Silt fence will be cleaned out when sediment builds up to half its height or maintained/replaced if damaged.

All temporary erosion control devices, including roadside ditches, will be inspected to confirm proper functioning at a minimum:

- During or immediately following initial installation;
- At least once in every two-week period;
- Within 48 hours following any runoff-producing storm event; and
- At project completion prior to release of any performance bonds.

For projects requiring a **stormwater pollution prevention plan (SWPPP)**, the following shall also apply:

- At least once every five business days, *or* at least once every 10 business days and within 24 hours following a runoff-producing event.

For projects discharging to exceptional waters impaired waters, and/or waters with approved total maximum daily loads (TMDLs), the following shall also apply:

- At least once every four business days, *or* at least once every five business days and within 24 hours following a runoff-producing event.

For FERC-regulated projects, the following shall also apply:

- On a daily basis in areas of active construction or equipment operation;
- On a weekly basis in areas with no construction or equipment operation; and
- Within 24 hours of each 0.5-inch of rainfall.

Inspections of these temporary devices can only be performed by a VADEQ-certified **ESC Inspector**; refer to Section VI.B and the Annual Standards for additional information on qualifications for ESC Inspectors. If a project is subject to several of the inspection requirements above, the ESC Inspector will conduct the most stringent inspection frequency. Refer to Section III.A of the Annual Standards for additional information on inspection frequency.

Any required repairs shall be made within 24 hours of identification, or as soon as conditions allow if compliance within this time frame would result in greater environmental impacts. The VESCH specifications in Attachment A also provide details on inspection, repair, and replacement for individual ESC practices.

All temporary **sediment filter devices** will be maintained in place until permanent revegetation measures are successful or the upland areas adjacent to wetlands, waterbodies, or roads are stabilized. In accordance with MS-18 (Attachment B), all temporary ESC measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the local program authority. Trapped sediment and disturbed soil areas resulting from the removal of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

4. Temporary Road Entrances

Temporary road entrances will be installed, in accordance with VESCH 3.02 Temporary Stone Construction Entrance (Attachment A), during grading where the CWA crosses paved or public roads, when needed to maintain safe conditions, and to prevent tracking soil and mud onto public roads. These installations are designed to remove mud from vehicle tires and tracks before they access the road. The use of tracked equipment on public roadways shall be minimized to prevent roadway damage and minimize the transport of sediment by vehicular tracking onto the paved surface. Geotextile fabric will be used as illustrated on Figure 17 and as specified in VESCH 3.02 Temporary Stone Construction Entrance in Attachment A. The roadbed should be cleared of small stubs, which tend to puncture the fabric, thereby allowing fine particles to mix with the gravel. If necessary, up to 6 inches of soil will be removed prior to installation of the temporary road entrance to ensure a hard base for geotextile fabric and rock placement. In accordance with MS-18 (Attachment B), temporary road entrances shall be removed within 30 days following final site stabilization or after they are no longer needed, unless otherwise authorized by the VESCP authority. Trapped sediment and disturbed areas resulting from removal activities will be permanently stabilized.

In addition, paved or public roads will be swept, shoveled, or scraped to keep the road surface safe. The road surface shall be cleaned thoroughly at the end of each day. Any damages to roadway surfaces, shoulders, and bar ditches will be repaired. Typical erosion control measures at road crossings are illustrated on Figure 16.

5. Access Roads

Typically, TC Energy requires access roads to construction and staging areas. New access roads will be built only if existing access is inadequate. Access roads will be a maximum of 25 feet wide with additional width in tight turns and at intersections with public roads (this additional width must also be included in the environmental surveys and approvals). The roads will be built in accordance with VESCH 3.03 Construction Road Stabilization (Attachment A), and either be temporary (used for access during construction only) or permanent (used during and after construction for operation and maintenance of the facilities). In accordance with MS-18 (Attachment B), temporary roads shall be removed within 30 days following final site stabilization or after they are no longer needed, unless otherwise authorized by the VESCP authority. Permanent roads, or access roads intended to be left permanently by TC Energy or landowner request, may require additional permitting, including development of a **Stormwater Management (SWM) Plan**, by VADEQ or local **Virginia Stormwater Management Program (VSMP)** authority request if they significantly affect the predevelopment runoff characteristics in accordance with **Virginia Guidance Memo No. 15-2003 (GM 15-2003)** (Appendix C of the Annual Standards). All public roads are available for use as access roads without further environmental review.

However, all private access roads intended for use are subject to environmental and cultural survey reviews, as well as permitting prior to their use. Safe and accessible conditions will be maintained at all roadway crossings and access points during construction and restoration.

If tree clearing is needed for access road use, trees should be felled into the CWA of the access road itself. All trees and brush will be windrowed at the edge of the access road, with usable timber kept separate. The access road gradient will be as flat as local topography will practically allow. By breaking or changing grade frequently, fewer erosion problems will be encountered than on long, straight, continuous gradients. Temporary ROW diversions and/or other ESC devices will be installed as needed. Temporary ROW diversions (see VESCH 3.11 Temporary Right-of-Way Diversion) shall be inspected in compliance with FERC regulations. Refer to Section II.D.3 for a list of inspection requirements. Temporary ROW diversions subject to damage from construction equipment shall be reshaped at the end of each working day.

Roads will cross streams and wetlands as close as possible to right angles. Road gradients approaching these crossings may be flattened to decrease runoff velocity. Runoff will be dispersed just prior to the crossing by means of a temporary ROW diversion with a sediment filter device at the outlet. Where conditions permit, new roads will be located at least 25 feet from any stream or wetland except at crossing locations. At crossing locations, a temporary equipment crossing shall be installed. Culverts will be sized and placed to permit water flow under the access road in accordance with VESCH 3.24 Temporary Vehicular Stream Crossing in Attachment A. If culverts will be crossed more than twice in a 6-month period and if the structure will remain in place for up to 14 days, the culverts shall convey the flow from a 2-year frequency storm event without altering the stream flow characteristics. If the structure will remain in place 14 days to 1 year, the culverts shall be large enough to convey the flow from a 10-year frequency storm event. The hydrologic calculation and subsequent culvert size must account for the specific watershed characteristics. If the structure must remain in place more than 1 year, it must be designed as a permanent measure by a qualified professional.

After construction, temporary access roads (including any additional width used for construction) may be graded and left intact for the landowner's benefit or will be removed and the area restored using the sample specifications as applied to the rest of the CWA.

E. Residential Areas

The following mitigation measures will be implemented for all residences within 50 feet of the CWA:

- Mature trees and landscaping will not be removed from within the edge of the CWA unless necessary for safe operation of construction equipment or as specified in landowner agreements;
- Immediately after backfilling the trench, all lawn and landscaping will be restored to final restoration conditions, or temporary restoration conditions pending weather and soil conditions;
- The edge of the CWA adjacent to the residence will be safety fenced for a distance of 100 feet on either side of the residence; and
- If seasonal or weather conditions prevent compliance with these measures, temporary erosion controls must be monitored and maintained until conditions allow completion of restoration.

F. Trenching

1. Trenching Specifications

Typically, the trench will not remain open for more than 30 days in any area unless authorized by the EI (additional restrictions for stream and wetland areas are provided in Section III). No more than 500 feet of open trench is allowed without a variance from the Environmental Permitting Group and

VADEQ.

As the trench is completed, trench line breakers as illustrated on Figure 13 will be installed **promptly** at every permanent ROW diversion at a minimum, or at increased intervals as approved by the EI. Topsoil will not be used to construct the breakers. Breakers reduce water velocity and erosion of the trench bottom and will be maintained promptly. Soft earth plugs (to the top of the trench) should be installed in the trench above public roads on slopes greater than 30 percent where the trench will remain open for more than 7 days. Soft earth plugs shall be installed per the same spacing as temporary trench line breakers. When pipe is installed in the trench, sandbag breakers shall be utilized in accordance with FERC requirements.

Sediment filter devices will be installed around spoil storage areas before digging bore pits, stream crossings, and wetland crossings.

If it is necessary to pump water from the trench, bore pits, or other areas within the CWA, the water will be pumped into a heavily vegetated upland area where the water will filter back into the ground, into a sediment trap as specified in VESCH 3.26 Dewatering Structure (Attachment A), into a properly installed sediment filter bag as illustrated on Figure 14, and/or through a sediment filter device such as a compost filter sock at least 10 feet from any stream or wetland in order to minimize erosion and subsequent sedimentation of streams or wetlands. If little vegetation is present, straw bales or compost filter sock containment will be added around the filter bag for additional sediment control. Water impounded in the trench will not be released directly or by overland flow into any waterbody or wetland. The trench shall be dewatered in a manner that does not cause erosion and does not result in heavily silt-laden water flowing into a waterbody or wetland. Dewatering structures will be removed as soon as practicable after completion of dewatering activities.

When the trench must remain open for a greater length of time, appropriate erosion controls and safety measures will be employed as directed by the EI.

2. Blasting

All blasting will be done in a cautious manner, and suitable precautions will be taken to avoid injury or damage to persons, livestock, or other property. TC Energy will use appropriate methods (e.g. blasting mats) when needed to prevent damage to nearby structures and to prevent debris from entering sensitive environmental resources

If blasting is necessary within 150 feet of residential or commercial buildings, an independent contractor will be hired to perform pre- and post-blast structural inspections and, if necessary, seismographic monitoring.

In those instances where blasting has the potential to affect water quantity/quality from domestic or agricultural wells or springs in the proximity of the CWA, TC Energy will conduct pre- and post-blasting (within two months of construction work restoration) testing of water wells within an appropriate distance (typically 150 feet) of the pipeline with landowner permission. These tests may include a pump inspection, flow rate measurement, and bacteriological cultures. If a water well is damaged as a result of TC Energy's activities, TC Energy will provide a temporary source of water and/or compensate the owner.

3. Temporary Construction Access over the Trench Line

Where access across the trench line is required, temporary facilities such as trench line breakers and fences, air bridges, wooden mats, or steel plates will be constructed or installed to permit safe crossing of livestock, vehicles, equipment, and persons from one side of the trench to the other.

4. Drainage Tile and Irrigation Facilities

An attempt will be made to locate existing drain tiles and irrigation systems. TC Energy personnel will contact landowners and/or the local soil conservation authorities to determine the locations of future drain tiles that are likely to be installed within three years of the authorized construction. If planned, the pipeline will be installed at a sufficient depth to accommodate the drainage tile. For adjacent pipeline loops in agricultural areas, the new pipeline will be installed with at least the same depth of cover as the existing pipeline(s) and within **U.S. Department of Transportation (US DOT)** specifications. Locations of drain tiles damaged during construction shall be marked.

Qualified drain tile specialists will be engaged, as needed, to conduct or monitor repairs to drain tile systems affected by construction. Drain tile specialists from the project area shall be used, if available. Drainage tile removed, cut, broken, or otherwise damaged during construction will be repaired or replaced in accordance with Figures 25 and 25A. Temporary measures approved by the EI will be taken to provide suitable drainage until permanent repairs are made. Damaged drain tiles will be repaired to their original or better condition. Filter-covered drain tiles shall not be used unless the local soil conservation authorities and landowner agree.

Water flow will be maintained in crop irrigation systems unless shutoff is coordinated with affected parties. TC Energy will monitor and correct problems with drainage and irrigation systems resulting from pipeline construction in agricultural areas until restoration is successful.

G. Backfilling Specifications

Backfilling will follow pipe lowering as closely as practical. Topsoil will not be used to pad the pipe. Soil that has been excavated during construction and not used for backfill will be evenly spread over the cleared CWA or be removed from the site and properly disposed of. Waste materials such as trash, stumps, coating and wrap, rubbish, or other refuse will not be placed in the trench.

Trench line barriers as illustrated on Figure 13 will be placed in the trench prior to backfilling to prevent water movement and subsequent erosion. An engineer or similarly qualified professional shall determine the need for and spacing of trench line barriers. Otherwise, trench line barriers shall be installed as specified in Figure 13 and upslope of any permanent diversions. Trench line barriers may be constructed of materials such as sandbags or polyurethane foam. Foam barriers can be used if the appropriate state or local governing agencies allow.

Excess rock, including blast rock, may be used to backfill the trench to the top of the existing bedrock profile. Care should be taken to not damage the pipeline.

H. Final Grading, Restoration, and Stabilization

After construction activities, all disturbed areas will be stabilized with either (1) final grading and restoration; or (2) **temporary stabilization** measures in order to prevent erosion and sedimentation until final grading and restoration can be completed. If construction or restoration unexpectedly continues into the winter season when conditions could delay successful decompaction, topsoil replacement, or seeding until the following spring, a winter construction plan will be filed with the FERC Secretary for review and written approval of the FERC Director of the Office of Energy Projects. This does not apply to projects constructed under the automatic authorization provisions of FERC's regulation.

1. Final Grading

Final grading, topsoil replacement, and installation of permanent erosion controls will be completed within 20 days of backfilling the trench (10 days in residential areas). If season or other weather conditions prevent compliance with these time frames, maintain temporary erosion controls and mulch until conditions allow for completion. Where an area will remain dormant for more than 14 days, the EI will act in accordance with MS-1 (Attachment B) and require the installation of temporary stabilization measures within 7 days. In no case shall final grading be delayed beyond the end of the next recommended seeding season.

If final grade can be established, but conditions are not ideal for permanent seeding, the EI, in accordance with the VESCH, will specify application of temporary stabilization measures (including temporary seeding and mulching), and may also consider concurrent application of final seed mix and mulch. Permanent stabilization measures will be applied to areas planned to be left dormant for more than one year. A travel lane built in accordance with VESCH 3.03 Construction Road Stabilization (Attachment A) may be left open temporarily to allow access by construction traffic if the temporary erosion control structures are installed, inspected, and maintained. When access is no longer needed, the travel lane must be removed and the CWA restored. The CWA will be graded to restore pre-construction contours.

During final grading, soil over the trench may be mounded to allow for future settling. Where fill in the trench or major depressions has settled below ground level, additional fill will be added as needed, and the area brought to final grade.

Conserved topsoil will be returned during final grading. Excess rock will be removed from at least the top 12 inches of soil to the extent practicable in all cultivated or rotated crop land, hayfields,, residential areas, and other areas at the landowner's request. The size, density, and distribution of rock on the CWA should be similar to adjacent areas not disturbed by construction. Rock that is not returned to the trench is considered construction debris, unless approved for use as mulch or for some other use on the CWA by the landowner or land managing agency. Construction debris from all work areas must be removed unless the landowner or land managing agency approves leaving materials on site for beneficial reuse, stabilization, or habitat restoration. Disposal of materials for beneficial reuse must not result in adverse environmental impact.

Final erosion control devices will be installed during final grading. Sediment filter devices needed to protect resources will be installed or rebuilt immediately after final grading. See VESCH 3.11 Temporary Right-of-Way Diversion and VESCH 3.12 Diversion in Attachment A for installation and spacing details. Permanent diversions will be constructed such that water does not pond in them and is conveyed off the CWA. Sediment filter devices needed to protect adjacent or off-CWS resources will be installed or rebuilt promptly during final grading. Permanent diversions will not be installed in agricultural or pastureland without landowner consent or may be removed at the request of the landowner and a suitable alternative installed until adequate revegetation has been established.

2. Soil Compaction Testing

Topsoil and subsoil will be tested for compaction at regular intervals in agricultural and residential areas disturbed by construction activities. Tests shall be conducted on the same soil type under similar moisture conditions in undisturbed areas to identify approximate preconstruction conditions. The U.S. Army Corps of Engineers style cone penetrometers or other appropriate devices shall be used to conduct tests.

Severely compacted agricultural areas shall be plowed with a paraplow or other deep tillage implement. In areas where topsoil has been segregated, the subsoil shall be plowed before the segregated topsoil is replaced. If subsequent construction and cleanup activities result in further compaction, additional tilling may be conducted.

Slopes should be roughened by stair-step grading, grooving, or using tracked machinery in accordance with VESCH 3.29 Surface Roughening in Attachment A to increase infiltration and reduce erosion.

TC Energy will perform appropriate soil compaction mitigation in severely compacted residential areas.

3. Restoration

Restoration as defined in Section X will begin within six (6) days of final grading, weather and soil conditions permitting. A seedbed shall be prepared in disturbed areas to a depth of 3 to 4 inches for firmness. In rocky soils, fertilizer and lime may be incorporated into the soil with tracked equipment. Seeding and mulching of the CWA will promptly follow seedbed preparation. Mulch will be anchored promptly after installation. Mulch tackifiers used in accordance with the manufacturer recommendations may be used as well. Liquid mulch binders will not be used within 100 feet of wetlands or waterbodies. Permanent or temporary soil stabilization shall be applied to denuded areas within six (6) calendar days after the final grade is reached on any portion of the site.

In accordance with VESCH 3.35 Mulching in Attachment A, hay or straw mulch shall be applied at 2 tons per acre over hydroseeding. Hydromulch can be applied at a rate of 500 to 750 pounds per acre in conjunction with (for texture purposes), but not substituted for, hay or straw mulch. The seedbed should be **scarified** to facilitate lodging and germination of seed.

TC Energy will follow the VADEQ Seeding and Soil Additive Requirements. Refer to Erosion & Sediment Control Technical Bulletin No. 4 found at www.deq.virginia.gov/Portals/0/DEQ/Water/Publications/ESCTechnicalBulletin4.pdf and in Attachment C. If tall fescue is used, endophyte-free certified seed shall be planted.

If hydroseeding is utilized, lime and fertilizer applications should be equivalent to conventional method applications unless the ROW agreement, permit, or local Natural Resources Conservation Service provides project-specific recommendations.

Seed shall be uniformly applied and covered in accordance with VESCH 3.32 Permanent Seeding and 3.35 Mulching (Attachment A), and any written recommendations of VADEQ or local agencies.

Pure live seed should be used within 12 months of seed testing. Legume seed should be treated with an inoculate specific to the species. For conventional seeding, 4 times the manufacturer recommended rate of inoculate should be used. For hydroseeding, 10 times the recommended rate of inoculate should be used.

In the absence of recommendations from the local conservation authority, a seed drill equipped with a cultipacker is preferred for application, but broadcast or hydroseeding can be used at double the recommended seeding rates. Where seed is broadcast, the seedbed shall be firmed with a cultipacker, roller, or other suitable means after seeding.

Jute netting as illustrated in VESCH 3.36 Soil Stabilization Blankets & Matting (Attachment A) or equivalent approved by the EI may be used on slopes with a gradient of 33 percent or greater (also referred to as a 3H:1V grade; 3 horizontal units to 1 vertical unit) to help stabilize the CWA. Coconut fiber erosion control blanket/netting should not be used.

Synthetic monofilament mesh/netted erosion control materials should not be used in areas designated as sensitive wildlife habitat, unless the product is specifically designed to minimize harm to wildlife. Erosion control fabric shall be anchored with staples or other appropriate devices.

Restoration will not be performed in agricultural lands from the beginning of the spring thaw through May 15 unless requested by the landowner. Restoration will be coordinated with the landowner's planting schedule. Grazing deferment plans will be developed with willing landowners, grazing permittees, and land management agencies as appropriate to minimize grazing disturbance of revegetation efforts. See Table 2f for fertilizer and lime application rates.

Permanent seeding, liming, and fertilizing may be performed by the landowner. The EI will ensure that the restoration is satisfactory and consistent with the VESCH and regulatory requirements.

A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. In accordance with MS-3 (Attachment B), permanent vegetation shall not be considered established until a ground cover is achieved that is uniform, is mature enough to survive, and will inhibit erosion. Follow-up inspections will occur after the first and second growing season.

All turf, ornamental shrubs, and specialized landscaping shall be restored in accordance with the landowner's request, or the landowner shall be appropriately compensated. Restoration work must be performed by personnel familiar with local horticultural and turf establishment practices.

In non-agricultural areas, revegetation shall be considered successful if upon visual survey the density and cover of non-nuisance vegetation are similar in density and cover to adjacent undisturbed lands. In agricultural areas, revegetation shall be considered successful if crop yields are similar to adjacent undisturbed portions of the same field, unless the easement agreement specifies otherwise. Revegetation efforts should continue until revegetation is successful. If revegetation is not successful, the area will be reseeded immediately and, if the reason for the poor germination is determined, any corrective actions required to promote germination shall be made prior to reseeding.

Problems with drainage and irrigation systems resulting from pipeline construction in active agricultural areas will be monitored and corrected until restoration is successful. Problems with drainage and irrigation systems resulting from construction activities will be reported to the local Operations Team Leader, and corrective measures will be performed as soon as practical, but no later than seven days following identification of the need for corrective measures.

Erosion problems on the facility ROW and access roads will be reported to the local Operations Team Leader or the Natural Resource Permitting Group and corrective measures will be performed as soon as practical, but no later than seven days after identifying the need for corrective action(s).

In accordance with MS-18 (Attachment B), temporary ESC measures will be removed within 30 days of final site stabilization, or after they are no longer needed, unless otherwise authorized by the VESCP authority. Removal of the erosion control devices will be at the discretion of the local Operations Team Leader and the Engineering & Construction Department.

4. Temporary Stabilization

When the EI determines that temporary stabilization measures are required, they will be completed as soon as possible. Consideration will be given to the following when determining if temporary stabilization measures are to be implemented:

- Whether unsuitable soil conditions persist, or are expected to persist, for more than 14 calendar days during final grading;
- Whether unsuitable weather conditions are anticipated;
- Whether construction or restoration activities will be interrupted for an extended period of time due to seasonal changes (winter); and
- Need to protect resources on and off the CWA.

If temporary stabilization measures are utilized, final grading and/or restoration must commence when weather and soil conditions permit. Temporary stabilization measures will be utilized for disturbed areas that may not be at final grade but will remain dormant for longer than 14 calendar days.

Seeding and mulching rates are provided in Table 2a. Mulch shall be applied in accordance with VESCH 3.35 Mulching (see Attachment A).

5. Restoring Manmade Structures

Existing manmade installations that are disturbed or damaged during construction along new ROW will be repaired or replaced and left in equivalent or better condition than they were found prior to construction, unless alternate arrangements with landowners dictate otherwise. Manmade installations on existing ROW that are disturbed or damaged during construction will be addressed consistent with TC Energy's encroachment policy.

6. Off-Road Vehicle Control

TC Energy will discuss with each landowner or land managing agency in forest lands the need for **off-road vehicle (ORV)** control. If requested, one or more of the following ORV control measures will be implemented:

- Planting of conifers (pine trees) across the CWA. The spacing of trees and length of CWA planted should provide for adequate facility maintenance, but should be sufficient to limit access and to screen the ROW from view. Trees will not be planted directly over the pipeline.

- Installation of a slash and timber barrier, a pipe barrier, or a line of boulders across the CWA to restrict vehicle access.

- Installation of a locking gate with fencing extending a reasonable distance to prevent bypass in accordance with VESCH 3.01 Safety Fence (Attachment A).

- Installation of "No Trespass" signs in accordance with VESCH 3.01 Safety Fence (Attachment A).

Although TC Energy can implement the above practices to control ORVs, it cannot control landowners using ORVs on their own property.

I. Noise Impact Mitigation and Dust Control

Construction equipment will be properly muffled and maintained to avoid producing excessive noise near **noise-sensitive areas**, as needed.

Efforts will be made to control dust at sensitive areas such as residential areas and road crossings. Water trucks will be used at a minimum to dampen the work area if dust becomes a problem. If water trucks are not adequately managing dust, the EI can suggest additional dust control methods. These additional methods shall be implemented in accordance with VESCH 3.39 Dust Control (Attachment A).

J. Hydrostatic Testing

Typically, TC Energy verifies a facility's integrity by hydrostatic testing. Water can be drawn from local sources (streams, ponds, public water supplies) in a manner that minimizes impacts to the environment and other existing users, while maintaining adequate stream flow rates to protect aquatic life and downstream withdrawals. Water from exceptional state waters, waterbodies that provide habitat for federally listed threatened or endangered species, or streams utilized as public water supplies will not be used unless other water sources are not readily available and the appropriate federal, state, or local agency permits its use.

Intake hoses will be screened to prevent entrainment of fish.

Hydrostatic test manifolds will be located outside wetlands and riparian areas to the maximum extent practicable. Pumps used for hydrostatic testing that are within 100 feet of any waterbody or wetland must be located within secondary containment.

All required federal, state, and local approvals for the withdrawal and/or discharge of hydrostatic test water will be obtained prior to such activities. TC Energy will comply with all approval/permit conditions, which may include notifying the appropriate state agency of withdraw/discharge, collection of samples in accordance with permit conditions where required, and discharging in a manner to meet all discharge parameters where required.

All welds will be radiographically inspected or hydrostatically tested before pipe installation under waterbodies or wetlands.

The discharge of the hydrostatic test water will be performed in a manner that minimizes erosion and sedimentation to waterbodies. The energy of the released test water will be dissipated by discharging the water:

- Into a well-vegetated upland area;
- Into a tank(s);
- Into a body of water (with all required permits); or
- Through sediment filter devices and/or a sediment trap to filter out and/or settle out various particulate matter and allow it to infiltrate through the soil.

If necessary, the water discharge rate will be regulated, energy dissipation device(s) used, and/or sediment barriers installed to prevent erosion, streambed scour, suspension of sediments, or excessive stream flow. During the discharge, the EI must ensure that erosion and sedimentation are properly controlled.

Discharge is prohibited into exceptional state waters, waterbodies that provide habitat for federally listed threatened or endangered species, or streams utilized as public water supplies unless the appropriate federal, state, or local agency grants permission.

If methanol is used to dry the pipe during the test or injected after discharging the water, approval must be granted from the Environmental Permitting Group pending agency approvals. Excess methanol will be retrieved from the facility and used during subsequent operation of TC Energy's facilities. Methanol cannot be discharged to the environment.

This guidance is for hydrostatic testing of new pipe. Permitting requirements associated with hydrostatic testing of used pipe can be extensive. The Environmental Permitting Group should be contacted prior to testing any used pipe.

K. Post-Construction Activities and Reporting

Follow-up inspections must be conducted of all disturbed areas, as necessary, to determine the success of revegetation and to address landowner concerns. At a minimum, follow-up inspections must be conducted after the first and second growing seasons. If revegetation is unsuccessful, revegetation efforts should continue until restored ground cover is achieved that is uniform and mature enough to survive and will inhibit erosion.

For Section 7b and 7c projects, quarterly reports must be filed with the FERC Secretary documenting the results of follow-up inspections; any problem areas, including those identified by the landowner; and corrective actions taken for at least two years following construction. This does not apply to project construction under automatic authorization, prior notice, or advanced notification provisions in FERC regulations.

III. Stream and Wetland Crossings

A. Stream Crossings

1. General

The main objective of any waterbody crossing is construction of the pipeline in a manner that minimizes the extent and duration of project-related disturbance on wetlands and waterbodies, as well as erosion and subsequent sedimentation into the resource. Crossings will be constructed as close as possible to right angles with the waterbody channel. Adequate downstream flow rates will be maintained at all times to protect aquatic life and prevent the interruption of existing downstream uses. Each waterbody crossing will be treated as a separate construction entity, such that trenching, pipe installation, backfilling, and temporary stabilization or final restoration are completed in the minimum number of consecutive calendar days possible. Whenever a time limit is imposed (also see Section III.A.1) on a crossing procedure, that time limit is only applicable to trenching (except blasting), pipe installation, and backfilling (see time limits for restoration in Section III.A.9). The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed (including riprap placement). Clearing, grading, and equipment crossing installation and removal activities are not included as part of the separate construction entity. Construction equipment will not be allowed in the water except as indicated in this section.

Unless expressly permitted or further restricted by the appropriate federal or state agency in writing on a site-specific basis, in-stream work, except that required to install or remove equipment bridges, must occur during the following time windows:

- Coldwater Fisheries: June 1 through September 30
- Coolwater and Warmwater Fisheries: June 1 through November 30

In accordance with MS-12 (Attachment B), when work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport, and stabilize the work area to the greatest extent possible during construction. Non-erodible material shall be used for the construction of causeways and cofferdams. Earthen fill may be used for these structures if armored by non-erodible cover materials.

TC Energy will notify authorities responsible for potable water supply intakes located within 3 miles downstream at least one week before beginning work in the waterbody, or as required by state or local regulation. In addition, TC Energy will notify appropriate federal and state authorities at least 48 hours prior to trenching or blasting within a waterbody, or as specified within applicable permits.

When water levels are temporarily high, the EI will direct that starting any waterbody crossing be postponed until water levels subside.

Any extra work areas will be located at least 50 feet from the water's edge, except where the adjacent upland consists of actively cultivated or rotated cropland or other disturbed land. Where topographic conditions do not permit a 50-foot setback, the Environmental Permitting Group shall be contacted to coordinate FERC approval. In such cases, all extra work areas must be located at least 10 feet from the water's edge and limited to the size needed to construct the crossing. Pipe assembly for the waterbody crossing is usually performed in the extra work areas prior to or concurrently with trenching.

Standards relating to spill prevention at waterbodies are discussed in Section IV (Spill Prevention, Containment, and Control).

If the facility parallels a waterbody, at least 15 feet of undisturbed vegetation between the waterbody and the CWA shall be maintained except at the crossing location. Where waterbodies are adjacent to the CWA, sediment barriers shall be installed along the edge of the CWA as necessary to contain spoil and sediment within the CWA.

Waterbody buffers (extra work area setbacks, refueling restrictions, etc.) must be clearly marked in the field with signs and/or highly visible flagging until construction-related ground disturbing activities are completed.

a) Minor Waterbodies

Minor waterbodies will be considered those that are 10 feet wide or smaller at the top of the bank. Construction in the waterbody should be completed within 72 hours using the dam and pump (Figures 23 and 23A) or other dry-ditch methods (see VESCH 3.25 Utility Stream Crossing in Attachment A). If construction within the stream is anticipated to take more than 72 hours, the diversion channel crossing method should be conducted in accordance with VESCH 3.25 Utility Stream Crossing, unless otherwise approved by a VESCP authority.

b) Intermediate Waterbodies

Intermediate waterbodies will be considered those that are 10 to 100 feet wide at the top of the bank. Either the dam and pump (Figures 23 and 23A) or cofferdam utility crossing (see VESCH 3.25 Utility Stream Crossing in Attachment A) methods can be used for intermediate waterbody crossings. TC Energy will attempt to complete trenching and backfill work in the waterbody within 72 hours, unless site-specific conditions make completion within 72 hours infeasible. If construction within the stream is anticipated to take more than 72 hours, the diversion channel crossing method should be conducted in accordance with VESCH 3.25 Utility Stream Crossing, unless otherwise approved by a VESCP authority.

c) Major Waterbodies

Major waterbodies will be considered those that are 100 feet wide or larger at the top of bank. Major waterbodies could also include waterbodies that are smaller, if special conditions warrant that a site-specific plan be created, such as threatened or endangered species habitat, stream classification, or other factors. Due to their sensitive nature, major waterbody crossings will have site-specific construction plans approved by the Environmental Permitting Group and state and federal agencies. HDD may be considered as an alternative for these crossings.

2. Crossing Techniques

TC Energy typically utilizes dry-ditch (i.e., flume pipe, dam and pump, or HDD) methods to install pipelines across waterbodies. For crossings of coldwater fisheries, and coolwater and warmwater fisheries considered significant by the state, the pipeline should be installed using one of the dry-ditch methods.

Upland construction techniques may be used for waterbody crossings without perceptible flow at the time of the crossing, provided that the EI verifies that water is unlikely to flow between initial disturbance and final stabilization. In the event of perceptible flow while the crossing is ongoing, measures will be installed to convey water and protect the stream.

Typical crossing methods are described below:

a) Flume Crossing

This crossing method involves damming the stream and conveying flow through the work area using a pipe(s). Flume pipes will be installed after blasting (if necessary), but before any trenching; flume pipes will be aligned to prevent bank erosion and streambed scouring. Stream flow will be diverted through the flume pipe using a diversion structure made of appropriate materials (e.g., sandbags, sandbags with plastic liner, or equivalent). If necessary, energy dissipating devices can be installed at the flume discharge. The flume pipe shall remain during trenching, pipe laying, backfilling, and initial streambed restoration. The flume pipes can be removed once the final streambed and bank is complete.

See VESCH 3.25 Utility Stream Crossing in Attachment A for additional details on flume pipe crossings.

b) Dam and Pump

This crossing method involves damming the stream and transferring flow around the work area using pumps. Dams for this crossing method will be constructed of materials that prevent sediment and other pollutants from entering the waterbody (e.g., sandbags, clean gravel with plastic liner). Pumps will be appropriately sized and in sufficient number (both primary and back-up pumps) to maintain downstream flow; pump intakes will be screened to minimize fish entrainment, and the pump discharge will include an energy dissipating practice to prevent scouring. During the crossing, the dam and pump equipment will be continuously monitored.

See Figures 23 and 23A for additional details on dam and pump crossings. The dam and pump method has no listed equivalent in the VESCH, but is listed in The Virginia Stream Restoration & Stabilization Best Management Practices Guide as an approved method for temporary flow diversions.

c) Horizontal Directional Drill

This crossing method involves boring underneath the waterbody and pulling the pipe segments through the borehole. Each proposed HDD crossing location requires a site-specific plan. This plan will include drawings with the location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared, with a justification that the area of disturbance is limited to the minimum required for the crossing. The plan will also identify any aboveground disturbance or clearing between the HDD entry and exit workspaces. Contingency measures will be included in the plan that address how to manage an inadvertent drilling fluid release, and how an abandoned drill hole would be sealed if the HDD crossing is unsuccessful, if necessary.

3. Clearing

Tree and brush clearing will be performed as previously described in Section II.C. All cleared materials will be disposed of at least 50 feet from the water's edge.

4. Grading

Grading equipment will not enter the water to grade the banks. Waterbody banks will be graded only where, and as much as, necessary to permit safe and efficient operation of construction equipment. Sediment filter devices will be installed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place, in accordance with MS-4 (Attachment B); the devices shall also be installed as close to the water as practical and upslope in preparation for soil stockpile area(s) across the entire CWA. All disturbed areas within 50 feet of the water's edge will be promptly stabilized. The stabilization practice(s) (e.g., mulch) will be maintained until the waterbody crossing restoration is complete. Removable sediment filter devices will be installed across the travel lane. These removable sediment filter devices, if removed during the day, will be re-installed by the end of the workday or when heavy precipitation is imminent.

Spoil from grading will be piled within the CWA and at least 10 feet from the stream banks and upslope of sediment filter devices already in place so that it will not erode into the waterbody. On waterbody crossings with approaches sloped 5 percent or greater, temporary ROW diversions will be installed 50 feet from the water's edge to divert surface runoff into adjacent vegetation. If vegetation is sparse or nonexistent, a sediment filter device will be installed at the discharge of the diversion. Where waterbodies are adjacent to the CWA and the ground slopes toward the waterbody, sediment controls will be installed along the edge of the CWA as necessary to contain spoil and prevent sediment flow into the waterbody.

5. Temporary Vehicular Stream Crossings

In accordance with MS-13 (Attachment B), if a live waterbody must be crossed by construction vehicles more than twice in any six-month period, a temporary stream crossing shall be installed. Only clearing equipment and crew, and related equipment necessary for installation of a temporary stream crossing, will be permitted to cross a waterbody prior to installing the crossing. Federal, state, or local permits that prohibit this activity will supersede this requirement. The number of waterbody crossings will be limited to one per piece of clearing equipment, unless the stream is designated as an exceptional state water.

Temporary vehicular stream crossings, constructed in accordance with VESCH 3.24 Temporary Vehicular Stream Crossing (Attachment A), consisting of culvert(s) with clean rock backfill or equipment pads/mats will be installed prior to or during grading operations at all waterbodies. Equipment bridges are not required at minor waterbodies that do not have a state-designed fishery classification or protected status (e.g., agricultural or **intermittent** drainage ditches). However, if an equipment bridge is used, it must be constructed in accordance with this ECS document (see Section II.D.5 for installation requirements). All temporary vehicular stream crossings will be designed and maintained to prevent soil from entering the waterbody. Soil will not be used to construct or stabilize equipment bridges. If timber mats are used as equipment bridges, the mats must be in good condition, with no large holes that could allow sediment to enter the waterbody. If the bridge span is too long to accommodate timber mat or other types of equipment, then a railcar bridge may be utilized, as depicted in Figures 24 and 24A. In addition, removable sediment filter devices will be utilized at both ends of equipment bridges in accordance with Figure 12. Equipment bridges must be able to withstand and pass the highest flow expected to occur while the bridge is in place.

Culverts will be aligned to prevent bank erosion and streambed scour. If needed, energy dissipating devices will be installed downstream of the culverts. Culvert crossings will be sized as described in Section II.D.5.

Crossings will be constructed as close as possible to right angles with the waterbody channel; where necessary, the crossing may vary 15 degrees from a line drawn perpendicular to the stream centerline at the intended crossing location. The centerline of the approaching roadway shall coincide with the crossing alignment for at least 50 feet prior to the bank of the waterway. A water-diverting structure such as a diversion dike or temporary ROW diversion will be installed a maximum of 50 feet from the waterway bank on either side of the crossing; refer to VESCH 3.09 Temporary Diversion Dike and 3.11 Temporary Right-of-Way Diversion, respectively, in Attachment A for water-diverting structure design details.

Temporary equipment bridges will be removed as soon as practicable after permanent seeding. If there will be more than 1 month between final cleanup and the beginning of permanent seeding and reasonable alternative access to the CWA is available, remove temporary equipment bridges as soon as practicable after final cleanup.

6. Trenching

Notifications to jurisdictional agencies will be made at least two days prior to any trenching in waterbodies.

Sediment filter devices for trench spoil will be installed prior to commencing trenching activities. Sediment filter devices can be temporarily removed from the trench line to allow trenching activities to proceed.

Prior to trenching within the waterbody, water impounded in the upland trench will be pumped into a sediment trap, properly installed filter bag (VESCH 3.26 Dewatering Structure and Figure 14, respectively), and/or sediment logs. Prevent the flow of spoil or heavily silt-laden water into any waterbody. If little vegetation is present, add a straw bale or filter sock containment around the filter bag for additional sediment control. This methodology will also be utilized if dewatering of the waterbody trench is required before backfilling. Remove dewatering structures as soon as practicable after the completion of dewatering activities.

For new construction activities, the minimum depth of cover for all waterbody crossings is 48 inches in normal soils and 24 inches in consolidated rock.

Trench line breakers will be used at all waterbody crossings to prevent diversion of water into upland portions of the pipeline trench and to keep any accumulated trench water out of the waterbody. Trench breakers will be installed at the base of slopes greater than 5 percent where the base of the slope is less than 50 feet from a waterbody or wetland. Trench line breakers must be of sufficient size to withstand upslope water pressure.

7. Blasting

During the pre-planning of waterbody crossings, the need for blasting will be evaluated. If the evaluation is inconclusive, the waterbody bed will be tested for consolidated rock prior to trenching. Blasting will not be done within waterbody channels without prior approval from government authorities having jurisdiction and at least two days’ notice provided to the authority, or as specified in permits.

If the waterbody bottom is consolidated rock, it can be drilled and shot at any time prior to commencing the crossing. However, removal of shot rock, and any additional drilling, shooting, and material removal, must be completed within the minimum number of consecutive calendar days practical. The time frame for completing the crossing will immediately commence once a trench of appropriate dimensions is established.

8. Backfilling

Waterbody bottoms will be returned as near as practical to their original contours. Spoil from the trench will be used as backfill. Clean gravel or native cobbles will be used for the final 1 foot of fill in the backfilled trench in all coldwater fisheries.

The sediment filter devices at the water line will be promptly reinstalled after backfilling.

9. Restoration

The preferred restoration method is to immediately start to achieve final grade and restore the waterbody and its banks within 24 hours of backfilling. In the absence of site-specific seeding recommendations, the specifications listed in Table 2a will be used. If conditions do not permit the preferred method, the CWA not in use for access will be promptly rough graded and stabilized in accordance with Table 2b. For dry-ditch crossings, bank stabilization shall be completed before flow is returned to the waterbody channel.

Liquid mulch binders will not be used within 100 feet of waterbodies. For each waterbody crossed, a permanent diversion and a trench line breaker will be installed at the base of slopes near the waterbody. The trench line breaker should be located immediately upslope of the diversion. In some areas, with the approval of the EI, a diversion dike built in accordance with VESCH 3.09 Temporary Diversion Dike in Attachment A may be suitable as a sediment barrier adjacent to the waterbody.

All equipment bridges will be removed once access in the area is no longer required.

Replacement of waterbody banks will be at the approximate original contour. If the waterbody banks are such that an unstable final soil grade would result in erosion and vegetative stabilization is inadequate, the EI will require mechanical stabilization of the waterbody banks and/or constructing the waterbody bank to a more stable angle of repose, provided appropriate agency approvals have been obtained, as required. Mechanical stabilization includes riprap, gabions, jute netting, etc.

Unless otherwise specified by state permit, the use of riprap will be limited to areas where flow conditions preclude effective vegetative stabilization techniques, such as seeded erosion control fabric.

Disturbed riparian areas should be revegetated with native pre-construction vegetation in accordance with VESCH 3.22 Vegetative Stream Stabilization in Attachment A.

If riprap or gabion baskets are used, refer to VESCH 3.19 Riprap and VESCH 3.23 Structural Streambank Stabilization in Attachment A, respectively.

Soil stabilization blankets, such as jute netting or bonded fiber blankets at a minimum, shall be installed on waterbody banks at the time of final bank recontouring in accordance with VESCH 3.36 Soil Stabilization Blankets & Matting (Attachment A). Synthetic monofilament mesh/netted soil stabilization blankets cannot be used in areas designated as sensitive wildlife habitat unless the product is specifically designed to minimize harm to wildlife. The soil stabilization blankets shall be anchored with staples or other appropriate devices.

In accordance with MS-3 in Attachment B, permanent revegetation will be considered successful only when ground cover is achieved that is uniform and mature enough to survive and will inhibit erosion. All temporary ESC measures will be removed within 30 days after final site stabilization, or after temporary measures are no longer needed, unless otherwise authorized by the VESCP authority, in accordance with MS-18 (Attachment B).

B. Wetland Crossings

1. General

The main objective of any wetland crossing is to construct the pipeline and restore the original contour of the wetland. Wetlands will be marked in the field by a knowledgeable person prior to the start of construction. The EI will maintain these field markings during construction. A maximum 75-foot wide CWA may be used through wetlands.

Mulch will not be used as a temporary erosion control measure in wetlands.

Aboveground facilities will not be located in any wetland, except where the location of such facilities outside of wetlands would prohibit compliance with US DOT regulations.

When water levels are temporarily high, the EI will direct that starting construction in the wetland will be postponed until after the water levels subside.

Standards relating to spill prevention at wetlands are contained in Section IV (Spill Prevention, Containment, and Control).

Wetland crossings shall be conducted in accordance with the requirements set out in the project SWPPP, if applicable. All applicable federal, state, and local requirements pertaining to working in or crossing live watercourses shall be met, in accordance with MS-14 in Attachment B.

2. Crossing Techniques

For wetland crossings without standing water or saturated soils, upland construction techniques can be used provided the top 12 inches of soil taken from the trench is stockpiled separately from the remaining excavated material. The CWA may be used for access when the wetland soil is firm enough to avoid rutting or the CWA has been appropriately stabilized to avoid rutting (e.g., with timber matting, prefabricated equipment mats, or terra mats). In wetlands that cannot be appropriately stabilized, all construction equipment other than that needed to install the wetland crossing shall use access roads located in upland areas. Where access roads in upland areas do not provide reasonable access, all other construction equipment should be limited to one pass through the wetland using the CWA.

Wetland crossings in non-saturated soil wetlands will be constructed in a manner that minimizes the amount of time construction activities are occurring in the wetland, such as the length of time the topsoil is segregated and the trench is open.

Wetland crossings with standing water or saturated soils will be constructed as separate construction entities, such that trenching, pipe installation, backfilling, and restoration are completed in the minimum number of consecutive calendar days necessary. Clearing, grading, and equipment crossing installations are not included as part of the separate construction entity. The “push-pull” or “float” technique of pipe installation will be utilized whenever water and other site conditions permit. The pipeline should be assembled in an upland area unless the wetland is dry enough to adequately support skids and pipe.

If standing water or saturated soils are present or if construction equipment causes ruts or mixing of the topsoil and subsoil, **low-ground-weight** construction equipment should be used, or normal equipment should be operated on timber matting (only two layers), prefabricated equipment mats, or terra mats. Timber matting must be in good condition and not have large holes where sediment could enter the wetland. Tree stumps, rock, gravel, soil imported from outside the wetland, or brush will not be used to stabilize the CWA or as equipment pads in wetlands. All equipment mats and timber matting will be removed during restoration of the wetland, unless access is needed through the wetland, in which case timber matting will be left in place until final restoration.

Staging areas will be located at least 50 feet from the wetland edge except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land and will be limited to the minimum necessary to construct the crossing. If topographic conditions do not permit a 50-foot setback, these areas must be located at least 10 feet from the wetland's edge with prior approval from FERC, coordinated by the Natural Resource Permitting Group.

The only access roads, other than the CWA, that can be used in wetlands without FERC approval are existing roads that can be used with no modification and no impact on the wetland.

The operation of construction equipment in wetland areas should be limited to that needed to clear the CWA, dig the trench, fabricate and install the pipeline, backfill the trench, and restore the CWA. All other construction equipment shall use access roads located in upland areas to the maximum extent practicable. Where access roads in upland areas do not provide reasonable access, all other construction equipment should be limited to one pass through the wetland using the CWA.

Typical wetland crossings are illustrated on Figures 18, 19, and 20.

3. Clearing

Tree and brush clearing will be performed as previously described in Section II.C. Vegetation will be cut at ground level, leaving existing root systems in place, and vegetation will be removed from the wetland for disposal.

4. Grading

Grading in wetlands will consist of the minimum necessary for safe and efficient equipment operation. Pulling of tree stumps and grading activities will be limited to directly over the trench line. Grading or removing stumps or root systems from the remainder of the CWA in wetlands is prohibited unless the **Chief Inspector** and EI determine that safety-related construction constraints require removal of tree stumps from under the working side of the CWA. Areas where stumps are removed will be noted by the EI so, if necessary, those areas can be replanted with woody vegetation as described in wetland restoration (Section III.B.8).

Where wetlands are adjacent to the CWA, and the CWA slopes toward the wetland, sediment barriers should be installed along the edge of the CWA as a first step in any land disturbance activity and made functional before upslope land disturbance takes place, in accordance with MS-4 (Attachment B), to prevent sediment flow into the adjacent wetland. Additional measures shall be installed as necessary to prevent sediment flow into the wetland. These sediment barriers should be removed after successful CWA restoration has occurred. Sediment filter devices will be installed prior to conducting land disturbance activities across the CWA during grading of the wetland or adjacent upland, at any wetland edge, and maintained until CWA revegetation is complete. Sediment filter devices will be installed along the edge of the CWA as well, as necessary, to contain spoil and sediment within the CWA through wetlands. Temporary ROW diversions will be installed adjacent to wetlands. Locations for these devices are illustrated on Figures 18, 19, and 20.

5. Trenching

Sediment filter devices can be temporarily removed from the trench line to allow trenching activities to proceed. Spoil piles will be protected with sediment filter devices to prevent the flow of spoil off the CWA. In accordance with MS-2 (Attachment B), spoil piles will be temporarily stabilized in accordance with Section II.H.4. Trenching will not begin until the pipeline is assembled and ready for lowering in. If trench dewatering is required, the water will be filtered and discharged through a sediment trap (VESCH 3.13) and/or filter bag (Figure 14) and/or a series of sediment logs or flocculent logs or into a heavily vegetated area outside the wetland (where the water will filter back into the ground), so that no silt-laden water enters directly into a wetland or waterbody. Dewatering structure(s) will be removed as soon as possible after the completion of dewatering activities.

6. Blasting

During the pre-planning of crossing wetlands with standing water or saturated soils, the need for blasting will be evaluated. If the evaluation is inconclusive, the wetland will be tested for consolidated rock prior to trenching. If the wetland has consolidated rock, it must be drilled and shot as part of the single construction entity.

7. Backfilling

Spoil from the trench will be used as backfill. The surface will be re-contoured as closely as practical to the original so that drainage patterns will not be changed. In wetlands without standing water or saturated soils, the conserved topsoil layer will be returned to the surface during backfilling.

Sediment filter devices will be installed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place (i.e., prior to backfilling). Where the pipeline trench may drain a wetland, trench line barriers shall be constructed and/or the trench bottom sealed as necessary to maintain the original wetland hydrology. For each wetland crossed, a permanent diversion and trench line barriers shall be installed at the base of slopes near the boundary between the wetland and adjacent upland areas. Trench breakers must be installed at the base of slopes greater than 5 percent where the base of the slope is less than 50 feet from a waterbody or wetland and where needed to avoid draining a waterbody or wetland. The trench line barriers should be located immediately upslope of the diversion.

Concrete coating activities will not take place within 100 feet of any wetland, unless the EI determines there is no reasonable alternative. In this case, steps will be taken (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.

8. Restoration

Upon completion of construction in wetland areas with standing water or saturated soils, all access improvements will be promptly removed. In the absence of specific recommendations from conservation authorities, the seed mix and rate specified in Table 2b will be used. Fertilizer, lime, or mulch will not be used, unless required in writing by the appropriate federal or state agency.

Liquid mulch binders will not be used within 100 feet of wetlands. Asphaltic emulsions will not be used to stabilize much within 100 feet of wetlands.

TC Energy will consult with the appropriate land management or state agency to develop a project-specific wetland restoration plan, where required. The restoration plan will include measures for re-establishing herbaceous and/or woody species, controlling the invasion and spread of undesirable exotic species and monitoring the success of the revegetation and weed control efforts.

Attempts will be made to prevent the invasion or spread of undesirable exotic vegetation (e.g., purple loosestrife and phragmites) within wetland areas disturbed during construction. Typically, these efforts include TC Energy's wetland construction techniques and the use of approved herbicides. Monitor the success of wetland revegetation annually for the first three (3) years after construction or until wetland revegetation is successful. Revegetation should be considered successful if the cover of native herbaceous and/or woody species is at least 80 percent of the total area, and the diversity of native species is at least 50 percent of the diversity originally found in the wetland. If revegetation is not successful at the end of three (3) years, develop and implement (in consultation with a professional wetland ecologist) a remedial revegetation plan to actively revegetate the wetland with native wetland herbaceous and woody plant species. Continue revegetation efforts until wetland revegetation is successful.

Temporary sediment barriers located at the boundary between wetlands and adjacent upland areas will be removed following the completion of soil disturbing activities and achievement of final vegetative stabilization. Final vegetative stabilization is defined as a permanent vegetative cover that is uniform (e.g., evenly distributed), is mature enough to survive, and will inhibit erosion.

IV. Spill Prevention, Containment, and Control

A. General

Spills of any amount of petroleum products or polluting materials are to be prevented. All employees handling fuels and other hazardous materials must be properly trained. All equipment must be in good operating order and inspected on a regular basis. Fuel trucks transporting fuel to on-site equipment must travel on approved access roads. All construction crews should have sufficient supplies of absorbent and barrier materials to allow rapid containment and recovery of spilled materials, sufficient tools and materials to stop leaks, and know TC Energy's spill reporting procedure described in Section IV.B. The following will be followed to help avoid spills and minimize the impact of spills that accidentally occur:

- Bulk quantities of fuel should be stored in one location for the project. Adequate spill containment measures, such as containment dikes, combined with impervious lining will be installed before fuel storage tanks are filled, and will be maintained throughout the project. Bulk quantities of hazardous liquids (e.g., solvents and lubricants) will be stored at the fuel depot locations. Double-walled tanks should be within secondary containment as well.

- Equipment refueling will not be performed within 100 feet of any body of water or wetland, except by hand-carried cans (5-gallon maximum capacity), when necessary. If construction equipment must be refueled within 100 feet of a waterbody, the procedures outlined in the project-specific **Spill Prevention Control and Countermeasure (SPCC)** Plan will be followed. Care will be taken during refueling not to overfill or spill fuel onto the housing of equipment. Equipment refueling shall be conducted in accordance with applicable local, state, and federal regulations.

- Lesser quantities of fuel (up to 500 gallons) and solvents and lubricants (e.g., motor oils, hydraulic fluid) may be stored along the CWA as necessary to service equipment used for the project (quantities vary depending on the size of the CWA), provided that this storage does not conflict with other parts of the SPCC. Sorbent booms and cleanup kits will be kept at all storage locations and will be readily available at all times.

- All fuel storage areas will be located at least 100 feet from waterbodies, at least 200 feet from active private water wells, and at least 400 feet from municipal water wells, unless using an operational fuel storage area established on TC Energy property. No fuel storage areas will be located within any designated municipal watershed area (except at locations designated for these purposes by an appropriate governmental authority). Equipment servicing, lubricating, overnight parking, and refueling will also be in accordance with these requirements whenever possible (i.e., except when stationary equipment such as drilling rigs is being used). Where these conditions cannot be met, the EI will prepare a supplemental SPCC Plan, based on field conditions, to protect these resources.

- Use of hazardous materials for vehicle maintenance will follow the same requirements outlined above for equipment refueling. Impervious or sorbent materials will be placed under the work area before work begins. Additional sorbent materials will also be readily available. Waste materials created during maintenance (e.g., used oil) will be collected for proper disposal. The work site and the vehicle will be checked by a TC Energy inspector after the maintenance work is completed to verify that all hazardous materials are properly contained. All waste material, including partially used or empty containers, discarded parts, cleaning rags, and used sorbent materials, as well as discarded hazardous material containers (e.g., oil cans, grease tubes), will be collected for proper disposal.

- All motor fuel, lube oil, chemicals, and other polluting substances will be tightly sealed and clearly labeled during transportation and storage.

- Fuel trucks, pumps, mechanic's vehicles, the contractor's foremen's vehicles, TC Energy EI vehicles, all equipment, and each construction crew will be equipped with appropriately sized spill kits containing absorbent materials approved for petroleum products and have sufficient tools and material to stop leaks.

- Construction equipment will not be washed in any body of water or wetland, nor will runoff resulting from washing operations be permitted to directly enter any body of water or wetland area.

- Construction equipment, vehicles, materials, hazardous materials, chemicals, fuels, lubricating oils, and petroleum products will not be parked, stored, or serviced within 100 feet of bodies of water and wetlands. These activities can occur closer if the EI determines there are no reasonable alternatives and appropriate steps are taken to prevent spills and provide prompt cleanup in the event of a spill.

- Pumps operating within 100 feet of a waterbody or wetland boundary must have appropriate secondary containment systems.

- Concrete coating activities cannot be performed within 100 feet of a wetland or waterbody boundary, unless the location is an existing industrial site designated for such use. These activities can occur closer only if the EI determines there is no reasonable alternative and appropriate steps (including secondary containment structures) are used to prevent spills and provide for prompt cleanup in the event of a spill.

- All equipment will be checked, by a TC Energy inspector, daily for leaks prior to beginning work in bodies of water or wetlands. Steps will be taken to repair leaks or remove the equipment from service, if necessary.

If barge-mounted equipment is to be employed, the contractor will develop specific spill-prevention plans to be reviewed and approved by the Natural Resource Permitting Group.

B. Additional Spill Prevention Requirements

In addition to the requirements for preventing, controlling, and cleaning up spills described above, construction activities shall be conducted in accordance with the spill prevention requirements outlined in the project SWPPP. Refer to the Annual Standards document for information on SWPPP components and applicability. SWPPP requirements for spill prevention, containment, and control include:

- Identify the potential pollutant-generating activities and the pollutant that is expected to be exposed to stormwater;

- Describe the location where potential pollutant-generating activities will occur, or if identified on the site plan, reference the site plan;

- Identify all non-stormwater discharges, as authorized in Part I E of the **General VPDES VAR10 General Permit for Discharges of Stormwater from Construction Activities (VAR10 GP)**, that are or will be commingled with stormwater discharges from construction activity, including any applicable support activity;

- Identify the person responsible for implementing the pollution prevention practice or practices for each pollutant-generating activity (if other than the person listed as the qualified personnel);

- Describe procedures for providing pollution prevention awareness of all applicable wastes, including any wash water, disposal practices, and applicable disposal locations of such wastes, to personnel in order to comply with the conditions of VAR10 GP; and

- Describe the pollution prevention practices and procedures that will be implemented to:

- Prevent and respond to leaks, spills, and other releases including (i) procedures for expeditiously stopping, containing, and cleaning up spills, leaks, and other releases; and (ii) procedures for reporting leaks, spills, and other releases;

- Prevent the discharge of spilled and leaked fuels and chemicals from vehicle fueling and maintenance activities (e.g., providing secondary containment such as spill berms, decks, and spill containment pallets, providing cover where appropriate, and having spill kits readily available);

- Prevent the discharge of soaps, solvents, detergents, and wash water from construction materials, including the cleanup of stucco, paint, form release oils, and curing compounds through providing [i] cover (e.g., plastic sheeting or temporary roofs) to prevent contact with stormwater; [ii] collection and proper disposal in a manner to prevent contact with stormwater; and [iii] a similarly effective means designed to prevent discharge of these pollutants);

- Minimize the discharge of pollutants from vehicle and equipment washing, wheel wash water, and other types of washing (e.g., locating activities away from surface waters and stormwater inlets or conveyance and directing wash waters to sediment basins or traps, using filtration devices such as filter bags or sand filters, or using similarly effective controls);

- Direct concrete wash water into a leak-proof container or leak-proof settling basin. The container or basin shall be designed so that no overflows can occur due to inadequate sizing or precipitation. Hardened concrete wastes shall be removed and disposed of in a manner consistent with the handling of other construction wastes. Liquid concrete wastes shall be removed and disposed of in a manner consistent with the handling of other construction wash waters and shall not be discharged to surface waters;

- Minimize the discharge of pollutants from storage, handling, and disposal of construction products, materials, and wastes including (i) building products such as asphalt sealants, copper flashing, roofing materials, adhesives, and concrete admixtures; (ii) pesticides, herbicides, insecticides, fertilizers, and landscape materials; and (iii) construction and domestic wastes such as packaging materials, scrap construction materials, masonry products, timber, pipe and electrical cuttings, plastics, Styrofoam, concrete, and other trash or building materials;

- Prevent the discharge of fuels, oils, and other petroleum products, hazardous or toxic wastes, and sanitary wastes; and
- Address any other discharge from the potential pollutant-generating activities not addressed above.

C. Spill Cleanup

Spills occurring during construction, operation, and maintenance are to be reported immediately to the Monitoring Center at 1-800-835-7191 in accordance with TC Energy policies, plans, and procedures. If the call to the Monitoring Center is not returned within 30 minutes *and* the spill has impacted water, the person discovering the spill or release will contact the National Response Center at 1-800-424-8802 and report the release. That person will continue calling the Monitoring Center until a representative is reached.

In accordance with the State Water Control Law § 62.1-44.34:19 (Article 11), any such spills are also to be reported immediately to the appropriate VADEQ regional office, the emergency services coordinator of the locality expected to be impacted, and appropriate federal authorities. The law exempts facilities (including aboveground storage tank (AST) facilities storing oil) from the notification requirement if:

- The discharge of oil to state lands is in an amount less than twenty-five (25) gallons;
- The recordkeeping requirements of subsection C of § 62.1-44.34:19.2 have been met; and
- The oil has been cleaned up in accordance with the requirements of the statute.

Contact information for the regional offices can be found here: https://deq.virginia.gov/Programs/LandProtectionRevitalization/PetroleumProgram/Clean-upActivities/ReportingAPetroleumRelease.aspx

If a spill should occur, TC Energy will ensure immediate action is taken to minimize the impact of the spill and see that appropriate cleanup action is immediately undertaken.

In the event of a spill into or in the vicinity of bodies of water or wetlands, the following will occur immediately:

- The source will be immediately stopped;
- The spill will be contained by placing sorbing booms or constructing

dikes;

- The spill will be collected with sorbing materials or skimmed off water surfaces with booms, and/or the contaminated soil will be excavated; and
- The waste materials will be properly stored and disposed of in accordance with TC Energy policy.

The affected areas will be restored as closely as possible to their previous condition.

If the spill is such that TC Energy personnel or the on-site contractor cannot immediately and effectively respond, TC Energy's environmental contractor, which specializes in spill cleanup, will be employed.

V. Maintenance

A. General

Maintenance of TC Energy's ROWs is an ongoing process that is governed by TC Energy policy, certificate and permit conditions, landowner agreements, and, where applicable, the establishment of deed restrictions. On FERC-certificated pipelines, full-width vegetation maintenance clearing shall not be done more frequently than every three years. However, to facilitate periodic corrosion and leak surveys, a corridor not exceeding 10 feet in width centered on the pipeline may be maintained annually in an herbaceous state. In no case shall full-width vegetation maintenance clearing occur between April 15 and August 1 of any year on FERC-certificated pipelines.

Plant growth on the ROW will be inspected regularly and maintained for the life of the facility. ROWs are generally maintained by mowing or other mechanical means, and through the use of herbicides. Use of herbicides will follow TC Energy policy. Only those herbicides approved by the **United States Environmental Protection Agency (US EPA)** will be used. Herbicide use will be in accordance with existing regulations and label instructions.

Maintenance activities will be performed with emphasis on preservation and enhancement of the environment. All applicable certificate and permit conditions will be incorporated into the future maintenance plan of the facility.

Specific procedures when required by regulations will be developed in coordination with the appropriate agency to prevent the introduction or spread of noxious weeds and soil pests resulting from construction and restoration activities.

When an agency requires a reduction in runoff and/or pollutants from stormwater runoff, measures intended to meet the reduction(s) shall be implemented in accordance with the Virginia Runoff Reduction Method Instructions and

Documentation guidance document.

B. Waterbodies, Wetlands, and Environmentally Sensitive Areas

TC Energy will work cooperatively with appropriate government agencies in an effort to minimize the impacts of ROW maintenance in waterbodies, wetlands, and other environmentally sensitive areas.

Vegetation maintenance will be limited adjacent to waterbodies to allow a riparian strip at least 25 feet wide, as measured from the waterbody's mean high-water mark, to grow.

Herbicides and pesticides are prohibited from being used in or within 100 feet of a waterbody or wetland except as specified by the appropriate land management or state agency.

In wetlands, a corridor up to 10 feet wide, centered on the pipeline, will be maintained in an herbaceous state. In addition, trees located within 15 feet of the pipeline and greater than 15 feet tall may be selectively cut. All felled trees will be removed from the wetland.

For ROW maintenance activities such as mowing, clearing, and side-trimming, the following procedures must be followed to minimize impacts to streams:

- Avoid vehicular crossings of streams by using an alternate access, where feasible;
- If an alternate access is not feasible, sequence the work to minimize the number of vehicular crossings through the stream. A temporary equipment crossing shall be constructed if a live stream must be crossed more than twice in a six-month period, in accordance with MS-13 (Attachment B); the crossing shall be constructed in accordance with VESCH 3.24 Temporary Vehicular Stream Crossing (Attachment A); and
- When there is a likelihood of streambed and/or stream bank impacts (e.g., changes to the existing contour of the stream), vehicular stream crossings are not permissible in the watercourse. Contact the Natural Resource Permitting Group coordinator to discuss alternatives. A temporary equipment crossing (VESCH 3.24 Temporary Vehicular Stream Crossing in Attachment A) may be necessary.

Through TC Energy's system, listed threatened, endangered, or special concern species and their habitats have been identified for certain locations. In addition, eligible cultural resources, wetlands, and other environmentally sensitive areas may have been identified. In these instances, permits typically include maintenance provisions that must be adhered to for the life of the facility.

VI. Environmental Construction Management and Inspection

A. General

TC Energy is responsible for compliance with the environmental conditions contained in a project's EMCP, which include all permits and other approvals. At least one EI will be assigned to every project (or every spread for projects with more than one spread) and will report to the TC Energy employee in responsible charge. EIs shall have peer status with all other activity inspectors. TC Energy will assign the appropriate number of EIs, with the appropriate level of experience for the length of the construction project or spread, considering the number and significance of resources affected, as well as other factors.

B. Environmental Inspector

The EI and/or **Responsible Land Disturber (RLD)** is responsible for ensuring that the construction activity is performed in accordance with the environmental conditions of the EMCP and landowner requirements, and has the authority to stop work and order appropriate corrective action as outlined in Section VI.E. For construction activities that are found by the Environmental Permitting or Compliance Group to have minimal environmental impacts, the EI may also serve to monitor other construction functions.

Only VADEQ-certified ESC and **SWM Inspectors** are allowed to inspect ESC and SWM practices, respectively. All EIs must have completed the VADEQ Inspector for Erosion and Sediment Control and VADEQ Inspector for Stormwater Management training courses and passed the certification exams. With these certifications, the EI may fill the role of the ESC and SWM Inspectors.

The RLD is responsible for carrying out land disturbance in accordance with the approved Erosion and Sediment Control Plan. All RLDs are required to obtain the Responsible Land Disturber Certificate through the VADEQ Certification and Tracking System.

At a minimum, the EI shall be responsible for:

- Inspecting construction activities for compliance with the requirements of the EMCP, ECS, and any permits, landowner agreements, or FERC certificates obtained for the project;

- Identifying, documenting, and overseeing corrective actions that are conducted as necessary to bring an activity back into compliance;

- Verifying that the limits of the authorized CWA and locations of access roads are properly marked before clearing, and maintained throughout construction;

- Verifying the locations of drainage and irrigation systems;

- Identifying erosion/sediment control and stabilization needs in all areas;

- Ensuring that the design of temporary ROW and permanent diversions will not cause erosion or direct water into sensitive environmental resource areas including cultural resource sites, wetlands, waterbodies, and sensitive species habitat;

- Verifying that dewatering activities are properly monitored and do not result in the deposition of sand, silt, and/or sediment into wetlands or waterbodies, cultural resource sites, and sensitive habitats. If such deposition is occurring, the dewatering activity shall be stopped and the design of the discharge shall be changed to prevent recurrence.

- Verifying that dewatering structures are removed after completion of dewatering activities;

- Verifying the testing of subsoil and topsoil in agricultural and residential areas to measure compaction and determine the need for corrective action;

- Advising the Chief Inspector when environmental conditions (such as wet weather or frozen soils) make it advisable to restrict construction activities to avoid topsoil mixing or excessive compaction;

- Inspecting for restoration of contours and topsoil;

- Verifying that the soils imported for agricultural or residential use are noxious weed and soil pest free, unless otherwise approved by the landowner;

- Ensuring that temporary erosion controls are properly installed and maintained, daily if necessary, and determining the need for additional controls;

- Providing inspections at the appropriate frequency based on the project (see Section II.D.3 and/or Section III.A of the Annual Standards for information on inspection frequency):

- Documenting inspections on ESC Inspection Logs (Figure 28) and keeping completed Logs onsite during construction activities;

- Inspecting the repair of all ineffective erosion control measures;

- Keeping records of compliance with the environmental conditions of the EMCP, any certificates, and other federal or state environmental permits during construction, restoration, and post-construction monitoring. Keeping records of the mitigation measures proposed or approved as part of the FERC Order, and/or other federal/state/local environmental permit during active construction and restoration;

- Identifying areas that should be given special attention to ensure stabilization and restoration after the construction phase;

- Monitoring the success of restoration. Looking for evidence of contamination and, if found, ceasing activities in that area, notifying the Environmental Services Group and waiting for further instruction. If the contamination is determined to be hazardous, an experienced hazardous waste contractor will be mobilized to handle the waste; the hazardous waste contractor will follow a site-specific health and safety plan and standard operating procedures for working in hazardous environments, which is maintained by the Environmental Services Group;

- Verifying the locations of signs and visible flagging marking the boundaries of wetlands, waterbodies, and other sensitive resource areas or areas with special requirements along the CWA; and

- Verifying that the locations for disposal of excess construction materials for beneficial reuse comply with applicable laws and regulations.

Note that many of the responsibilities listed above can only be performed by a VADEQ-certified ESC and/or SWM Inspector; see the Annual Standards, the beginning of this Section, or Section X for additional information.

C. Environmental Training

TC Energy will be responsible for ensuring that the EI(s), other inspectors and any contractor's foreman, have been trained in all environmental aspects of the activity, and fully understands the environmental conditions contained in the activity's EMCP.

Environmental Permitting and Environmental Program Compliance groups will conduct training for construction personnel when sensitive resources are present or when permit/certificate conditions mandate, or when requested by the Team Leader.

D. Contractor's Environmental Foreman

For construction activities that utilize an outside contractor, the contractor will be required to provide at least one qualified Environmental Foreman. This person will become thoroughly familiar with TC Energy's EMCP for the activity.

The Environmental Foreman will be responsible for the contractor's efforts to correctly install and maintain environmental control devices and for construction in environmentally sensitive areas. The Environmental Foreman will work in cooperation with TC Energy's employees responsible for environmental compliance.

The Environmental Foreman must be available at all times during the project and have the appropriate number of available employees to adequately implement the project's EMCP.

E. Environmental Construction Management

The EI and each functional inspector shall have the authority to stop work on a particular construction function if it deviates from the environmental conditions of the activity's EMCP, as well as FERC Orders, stipulations of other environmental permits or approvals, or landowner easement agreements. The deviation shall be reported immediately to the TC Energy employee in responsible charge of the activity. The TC Energy employee in responsible charge, the Engineering & Construction Team Leader, and the Environmental Program Compliance or Environmental Permitting groups will be responsible for resolution of the deviation. The EI shall also have the authority to order appropriate corrective action(s).

Stop work authority for the entire construction activity rests with the TC Energy employee in responsible charge or the Engineering & Construction Team Leader.

Environmental Program Compliance may, from time to time, perform inspections of construction activities to review the implementation of the EMCP. Environmental Program Compliance will have stop work authority during these inspections should deviations from the activity's EMCP occur. Any corrective actions required shall be taken as soon as possible.

The Environmental Permitting and Environmental Program Compliance groups may, from time to time, perform inspections of construction activities to review the implementation of the EMCP. These groups will have stop work authority during these inspections should deviations from the activity's EMCP occur. Any corrective actions that are required shall be taken as directed.

VII. Environmental Variances

Unapproved variances from an EMCP and this ECS are not permitted. Any proposed variance from an EMCP or this ECS will require approval from the Environmental Permitting group prior to commencing the activity. The approval for a variance will be in writing. In instances where written approval is not practical (i.e., emergencies and weekends), verbal approval may be given provided that written confirmation is provided as soon as possible.

VIII. Emergency Construction

In the event of an emergency, the TC Energy employee in responsible charge will take such action as is necessary to contain the emergency giving due regard to minimizing environmental impact. In conjunction with other TC Energy policies, the requirements contained in this ECS document will be followed as closely as possible.

IX. Winter Season Construction Plan

A. General

TC Energy will typically initiate a winter season construction plan for projects taking place on or after November 1 of each season, as well as for projects for which all construction activities (including restoration) have not been completed prior to November 1 of each season. For the purposes of this winter season construction plan, the winter season is defined as November 1 through March 15 of each year. Environmental Program Compliance, in conjunction with the EI, will determine if soil temperatures, depth of soil freezing, snow accumulation, historical regional conditions, or pending weather forecasts dictate initiating the winter season construction plan prior to these dates, or allow for extending these dates. If a project's primary regulatory agency has winter construction regulations or permit conditions, TC Energy will defer to those, rather than this winter season construction plan.

The winter season construction plan applies to projects taking place within the portions of TC Energy's pipeline system where adverse winter conditions could be expected.

1. Snow Removal and Storage

Removal of snow from the construction workspace may be necessary to provide safe and efficient working conditions, as well as to expose soils for grading and excavation. Snow may also need to be removed along access roads to allow safe access to the ROW.

Snow storage will take place within ROW or approved workspaces. Care will be taken to avoid mixing snow with soil. Gaps will be provided in snow stockpiles to allow for site drainage or existing drainage patterns, with the appropriate ESC devices installed. Snow can also be blown off ROW, with landowner approval, and spread evenly to minimize damage to woody vegetation or other resources off ROW.

Snow may be used for beneficial uses, such as insulation over the trench line prior to excavation, if practical, or to reduce frost penetration along the trench line. Snow can also be used to build frost roads through wetlands and other saturated or otherwise unstable areas. Installation of temporary gates/fence crossings will occur prior to or concurrently with snow removal activities and in accordance with landowner requirements.

Construction signage will be used to designate sensitive areas, cultural resource sites, protected species habitat, or other avoidance areas to prevent inadvertent damage during snow removal activities.

2. Temporary Erosion and Sediment Control

In areas where shallow freezing occurs in the morning and evening followed by a daytime thaw, different construction activities may be approved or restricted by the Chief Inspector or EI, depending on the time of day. TC Energy will attempt to install the necessary temporary ESC devices in advance of the winter season, where possible. All erosion and sediment controls will be inspected on a weekly basis, within 24 hours of a runoff-producing storm event, within 24 hours of a large snowmelt event, and at project completion prior to release of any performance bonds. TC Energy will keep an EI and environmental labor crew on site or on call through the winter season and periods of thaw to monitor erosion control structures and stabilization efforts and make adjustments or repairs as necessary and as ROW conditions allow. Crews will have the proper equipment available to allow access to the ROW under soft soil conditions, such as all-terrain vehicles with oversized tires, to prevent rutting, topsoil mixing, and damage to other temporary erosion controls such as drivable berms.

3. Topsoil Segregation

Topsoil will be segregated during winter construction in the same locations and manner as during non-winter construction. In accordance with VESCH 3.30 Topsoiling in Attachment A, topsoil operations should not be performed when the soil is wet or frozen. Long-term topsoil stockpiling to manage the topsoil and accomplish more effective seeding and restoration may be necessary after the spring thaw.

Restoration of topsoil will ideally occur after both the stockpiled topsoil and the exposed subsoil have thawed, the ground has dried following the spring melt, and the soils are more easily worked. ROW stabilization measures will be implemented prior to topsoil restoration, regardless of whether it occurs under frozen conditions or is delayed until spring thaw. Some options for temporary stabilization of the ROW and segregated topsoil pile include mulching and dormant seeding.

If a landowner requests permanent stabilization be initiated within the winter season, TC Energy will comply with the landowner request and/or relevant terms of the landowner agreement.

4. Backfilling

The longer excavated materials from the trench are exposed to freezing ambient air temperatures, the more difficult it can be to properly backfill the trench with these materials. This may result in the perception that there is significant excess spoil material remaining after trench backfill is completed. Rather than removing the “excess” material, a slight crown could be created over the trench line to allow for subsidence once the material has thawed.

Crowning material over the trench or ditch line may be a suitable practice where trench subsidence is anticipated. The crown will be constructed directly over the backfilled trench with native material. Subsoil used to build the crown should not extend above natural surface grade. The crown will be capped with native topsoil material to ensure elevations will be restored with topsoil at the surface. Small gaps will be left in the crown to allow for natural surface drainage before the material is fully settled during spring and summer thaw. TC Energy will monitor for subsidence and excessive crowning conditions.

TC Energy will minimize the amount of open trench during frozen conditions to reduce the risk of freezing excavated spoil materials. Outer layers of a frozen topsoil pile will be stripped off in order to use unfrozen inner topsoil during backfilling, provided the topsoil is also not excessively wet; in accordance with VESCH 3.30 Topsoiling in Attachment A, topsoil operations should not be performed when the soil is wet or frozen. Outer layers of a frozen spoil pile will be stripped off in order to use unfrozen inner subsoil first during backfilling. The remaining frozen subsoil will be broken into smaller pieces prior to backfilling to reduce the size of voids in the backfilled trench. Specialized equipment may be needed to break up frozen backfill material to minimize future subsidence.

5. Restoration

The Natural Resource Permitting Group, in conjunction with the Project Manager and EI, will determine whether the project can be completely restored during the winter season or if permanent restoration activities will be delayed until after the spring thaw. If permanent restoration will take place during the winter season, the steps outlined in the upland portion of this ECS document (Section II), along with the requirements in Table 2a, will be followed. If permanent restoration will be delayed, subsoil will be left in a roughened condition to slow the sheet flow of water. Open areas will be backfilled or provided safety fencing for protection, except for pipelines left uncovered for longwall mining activities.

Disturbed areas for which permanent restoration cannot be completed will be mulched or have soil tackifiers applied. See Tables 2a and 2b for temporary stabilization application rates.

To ensure adequate vegetation growth when seeding during the winter season, higher seeding rates will be considered, to account for lower germination success, on a case-by-case basis. Cold weather grasses will also be utilized.

B. Wetland and Waterbody Crossing

Wetland and waterbody crossings during winter construction will be constructed in the same manner as during non-winter construction. Spoil material with high water content (e.g., non-cohesive soils) can freeze to the ground surface in its storage location. If this occurs, separation of wetland and other soils will take place to the maximum extent practicable.

The EI can delay wetland or waterbody crossings when winter conditions warrant such delay.

C. Dewatering

When dewatering activities are necessary during freezing conditions, pumps may have to be installed in small, heated shelters to prevent the pumps from freezing and becoming non-operational or to prevent damage to the pumps that could result in a spill or leak of lubricants or fuel. Dewatering activities performed during frozen conditions should be continuously monitored and adjusted as necessary. Discharge locations will be carefully evaluated and selected based on site conditions including vegetation cover, soil type, and topography. TC Energy will attempt to install dewatering structures (e.g., filter bags, portable sediment tank), in accordance with VESCH 3.26 Dewatering Structure in Attachment A and Figure 14, earlier in the construction process when ground conditions are favorable for installation, where feasible. Dewatering structures will be promptly removed after use to prevent freezing and proper cleanup. All spill prevention measures described in Section IV (Spill Prevention, Containment, and Control) of this ECS document will also be followed during winter season construction.

X. Definition of Terms

AGRICULTURAL LANDS: Permanent or rotated croplands, hayfields, and pastures.

ANNUAL STANDARDS: Annual Standards and Specifications for Erosion & Sediment Control and Stormwater Management.

CHIEF INSPECTOR: The Chief Inspector is responsible inspecting as necessary and coordinating with other project inspectors to ensure that a construction project proceeds in accordance with TC Energy standards.

COLUMBIA: Columbia Gas Transmission, LLC.

CWA: Construction work area; includes permanent and temporary right-of-way, contractor’s yards, pipe and material storage yards, access roads, and borrow or disposal areas.

ECS: Environmental Construction Standards.

EI: Environmental Inspector; responsible for environmental compliance on a construction project. The Environmental Inspector may fill in the roles of the ESC and SWM Inspectors, provided that the appropriate certifications have been met (see ESC INSPECTOR and SWM INSPECTOR definitions).

EMCP: Environmental Management and Construction Plan; general construction document that can incorporate site-specific erosion and sediment control plans where they are required and recommendations from regulatory agencies, and typically has some detail on erosion control, including temporary and permanent revegetation.

ESC: Erosion and sediment control.

ESC INSPECTOR: Erosion and Sediment Control Inspector; responsible for periodically examining the erosion and sediment control and land disturbance activities for compliance with applicable regulations. Completion of the Virginia Department of Environmental Quality Inspector for Erosion and Sediment Control training course and passing the certification exam is required to inspect erosion and sediment control devices.

ESC PLAN: Erosion and Sediment Control Plan; unlike the Environmental Management and Construction Plan, the Erosion and Sediment Control Plan includes more details on erosion and sediment control specifications and complying with applicable erosion and sediment control regulations.

EXCEPTIONAL STATE WATER: A stream or waterbody that constitutes an outstanding national, state, regional, or local resource, such as waters of national, state, or county parks or forests; waters that are used as a source of unfiltered potable water supply; waters of wildlife refuges or state game lands; waters that have been characterized by the Fish Commission as "Wilderness Trout Streams"; and other waters of substantial recreational or ecological significance. May also be referred to as Tier III Waters.

EXTRA WORK AREA: An area included within the construction work area that is needed in addition to the minimum area required for construction activities. Extra work areas typically include additional temporary workspaces or staging areas at railroad, waterbody, or wetland crossings; areas with steep slopes or where blasting is required; or areas at the beginning or end of a pipeline segment for mobilization/demobilization. Because extra work areas are within the construction work area, they are, at a minimum, permitted and protected in the same manner as the construction work area as described in the Annual Standards and the Environmental Construction Standards.

FERC: Federal Energy Regulatory Commission.

FINAL GRADING: Includes returning the construction work area as closely as practical to its original contour, redistributing conserved topsoil, soil compaction testing in agricultural lands, and installing permanent diversions.

GM 15-2003: VADEQ's Guidance Memo No. 15-2003.

HDD: Horizontal directional drilling; drilling method used for relatively long pipe installations and usually under environmentally sensitive sites such as large streams and wetlands. This method usually requires extra workspace for the drilling rig to set up and for the pipeline section to be welded together. After a pilot hole is drilled, the hole is reamed larger several times (depending on the diameter of the pipeline to be installed) by the drilling rig. When the desired diameter is achieved, the pipeline is pulled into the hole by the drilling rig.

IMMEDIATE: Without interval of time; "right now."

INTERMEDIATE WATERBODY: A waterbody greater than 10 feet at the water's edge at the time of construction.

INTERMITTENT: In reference to waterbodies, a channel that generally carries water in the spring or immediately after a rain event; designated on topographic maps and environmental construction drawings with a broken line.

LAND DISTURBANCE (ESC DEFINITION): Manmade change to the land surface that may result in soil erosion from water or wind and the movement of sediments into state waters or onto lands in the Commonwealth, including, but not limited to, clearing, grading, excavating, transporting, and filling of land. Use this definition when referring to land disturbance related to Virginia erosion and sediment control regulations. See LAND DISTURBANCE (SWM DEFINITION) for the definition of land disturbance as it relates to stormwater management.

LAND DISTURBANCE (SWM DEFINITION): Manmade change to the land surface that potentially changes runoff characteristics, including, but not limited to, clearing, grading, or excavation. Use this definition when referring to land disturbance related to Virginia stormwater Management regulations. See LAND DISTURBANCE (ESC DEFINITION) for the definition of land disturbance as it relates to erosion and sediment control.

LOW-GROUND-WEIGHT: Construction equipment that is designed “specifically for” or “frequently used in” areas where compaction and sinking are to be minimized. This equipment can be less than 5 pounds per square inch or contain wider tracks than the standard minimum size width tracks for the model equipment to be used.

MAJOR WATERBODY: A waterbody greater than 100 feet wide at the water's edge at the time of construction.

MINOR WATERBODY: A waterbody less than or equal to 10 feet wide at the water's edge at the time of construction.

MS-X: Virginia 9VAC25-840-40 Minimum Standards number XX (e.g., MS-1 refers to minimum standard 1).

NOISE-SENSITIVE AREA: Includes residences, schools, churches, cemeteries, hospitals, farms, camping facilities, and outdoor amphitheaters and playgrounds.

ORV: Off-road vehicle.

PROMPTLY: By the end of the work day.

RESTORATION: Includes fertilizing, liming, disking, seeding and mulching, and crimping mulch to establish a permanent vegetative cover. Final restoration with a permanent vegetative cover is considered as sufficiently established when ground cover is uniform, is mature enough to survive, and will inhibit erosion.

RLD: Responsible Land Disturber; individual (e.g., owner, applicant, permittee, designer, contractor, project manager) that is responsible for carrying out land disturbance in accordance with the approved Erosion and Sediment Control Plan. Requires obtaining a Responsible Land Disturber Certificate through the Virginia Department of Environmental Quality Certification and Tracking System.

ROW: Right-of-way.

SCARIFY: To make shallow cuts into the soil surface. This should be accomplished with a disk, rake, tracked equipment (grousers), or other suitable means.

SEDIMENT FILTER DEVICE: Properly embedded silt fence, wire-backed silt fence, super silt fence, or compost filter sock (VESCH 3.05 Silt Fence in Attachment A and Figures 10 and 11, respectively).

SPCC: Spill Prevention Control and Countermeasure Plan.

SUPPORT ACTIVITY: Construction activity required for a project that may be located on or off site, including, but not limited to, activities in concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, and borrow areas (i.e., sources of imported fill). The Virginia Erosion and Sediment Control Program authority may consider off-site activities (including but not limited to borrow and disposal areas) as included in the proposed land-disturbing area (i.e., construction work area), or proof of approval that the off-site activity is already covered under an approved Erosion and Sediment Control Plan. On-site or off-site support activities stormwater discharges can be covered under the General Virginia Pollutant Discharge Elimination System VAR10 General Permit for Discharges of Stormwater from Construction Activities provided the conditions in 9VAC25-880-30 are met; off-site support activities may also be covered under another state or Virginia Pollutant Discharge Elimination System permit.

SWM: Stormwater management.

SWM INSPECTOR: Stormwater Management Inspector; responsible for periodically examining the stormwater management activities and land disturbance activities for compliance with applicable regulations. Completion of the Virginia Department of Environmental Quality Inspector for Stormwater Management training course and passing the certification exam is required to inspect stormwater management measures.

SWM Plan: Stormwater Management Plan; document describing methods for complying with the Virginia Stormwater Management Program that was established to manage the quality and quantity of runoff from land disturbance and includes local ordinances, rules, permits, specifications, technical materials, policies and guidelines, and requirements for review, inspection, enforcement, and evaluation.

SWPPP: Stormwater Pollution Prevention Plan; document prepared using good engineering practices that identifies potential sources of pollutants that could impact stormwater and the implementation of practices or measures to mitigate potential impacts, and incorporates or references an Erosion and Sediment Control Plan, Stormwater Management Plan, and a Pollution Prevention Plan.

TEMPORARY STABILIZATION: Includes fertilizing, liming, disking, mulching, and seeding to establish a temporary vegetative cover that prevents erosion and sedimentation until final grading and restoration can be accomplished.

TMDL: Total Maximum Daily Load; sum of point, nonpoint, background wasteload allocations for a specific constituent (e.g., sediment, aluminum, oil & grease) for a particular waterbody or series of waterbodies.

UPLAND CONSTRUCTION: All areas that are not waterbodies, rivers, streams, or wetlands.

US DOT: United State Department of Transportation.

US EPA: United States Environmental Protection Agency.

VADEQ: Virginia Department of Environmental Quality.

VAR10 GP: General Virginia Pollutant Discharge Elimination System VAR10 General Permit for Discharges of Stormwater from Construction Activities.

VESCH: Virginia Erosion and Sediment Control Handbook.

VESCP: Virginia Erosion and Sediment Control Program.

VPDES: Virginia Pollutant Discharge Elimination System

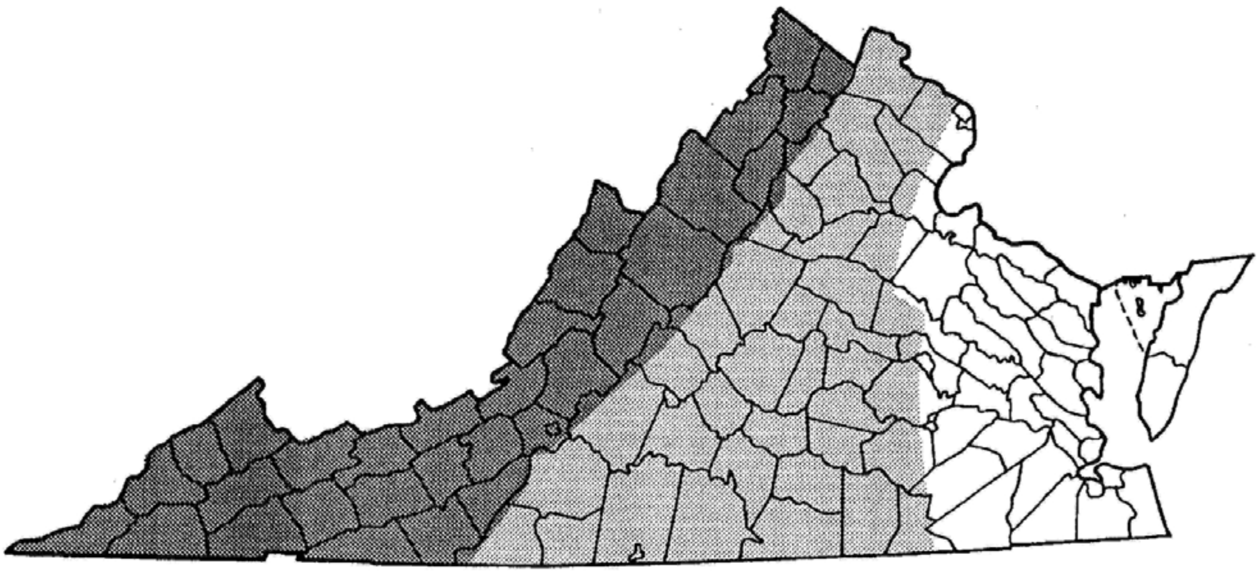
VSMP: Virginia Stormwater Management Program; program established to manage runoff quality and quantity resulting from land disturbance activities and accounting for items such as local ordinances, rules, permit requirements, annual standards and specifications, policies and guidelines, technical materials, and requirements for plan review, inspection, enforcement, and evaluation.

WATERBODY: Includes any natural or artificial waterbody, river, or drainage with perceptible flow at the time of crossing, and other permanent waterbodies such as ponds and lakes.

WETLAND: An area of special concern that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support plants adapted to saturated soil conditions such as rushes, sedges, cattails, or certain trees. Typically includes swamps, marshes, bogs, and any area that satisfies the requirements of the current federal methodology for identifying and delineating wetlands.

*Includes all grammatical variations of each term.

VIRGINIA PHYSIOGRAPHIC PROVINCES
REFERENCE GUIDE FOR
TABLES 2c, 2d, and 2e



PHYSIOGRAPHIC PROVINCES IN VIRGINIA

XI. Tables

Table 2a - Seed Mix for Temporary Stabilization	
Type	**Rate (lbs/acre)**
Seed	
Annual Rye or German Millet[1]	80
Mulch	
Hay or Straw	6000
[1]Use German Millett between May 1 and August 31	

Table 2b - Seed Mix Requirements in Wetlands	
Type	**Rate (lbs/acre)**
Seed[1]	
Annual Rye	80
[1]Annual rye is used as a temporary revegetative measure until indigenous plants reestablish cover. A monitoring program will be in effect to ensure adequate cover is established.	

Table 2c - Site-Specific Seed Mixtures for Appalachian/Mountain Area	
Seed Type	**Percentage of Seed Type (%)**
Minimum Lawn Care (Commercial or Residential) – 200-250 lbs per acre	
Turf-type tall fescue	90-100
Improved perennial ryegrass[1]	0-10
Kentucky bluegrass	0-10
High-Maintenance Lawn – 125 lbs per acre	
No less than three (3) and no more than five (5) varieties of bluegrass from an approved list for use in Virginia	100
General Slope (3:1 or less) – 150 lbs per acre	
Tall fescue	85
Red top grass	2
Seasonal nurse crop	13
Low-Maintenance Slope (Steeper than 3:1) – 150 lbs per acre	
Tall fescue	72
Red top grass	2
Seasonal nurse crop[2]	13
Crownvetch[3]	13

[1] Perennial ryegrass will germinate faster and at lower soil temperatures than fescue, thereby providing cover and erosion resistance for seedbed.

[2] Use seasonal nurse crop in accordance with seeding dates as stated below:

March, April through May 15 .... annual rye
May 16 through August 15 .... foxtail millet
August 16 through September, October .... annual rye
November through February .... winter rye

[3] If flatpea is used, increase to 20% of total. All legume seed must be properly inoculated. Weeping lovegrass may also be included in any slope or low-maintenance mixture during warmer seeding periods; add 10-20 lbs/acre in mixes.

Note: For all areas apply mulch (straw) at a rate of 1.5 to 2 tons per acre (minimum 2 tons per acre from November through February)

Table 2d - Site-Specific Seed Mixtures for Piedmont Area	
Seed Type	**Percentage of Seed Type (%)**
Minimum Lawn Care (Commercial or Residential) – 175-200 lbs per acre	
Turf-type tall fescue	95-100
Improved perennial ryegrass	0-5
Kentucky bluegrass	0-5
High-Maintenance Lawn – 200-250 lbs per acre	
Turf-type tall fescue	100
General Slope (3:1 or less) – 150 lbs per acre	
Tall fescue	85
Red top grass	2
Seasonal nurse crop	13
Low-Maintenance Slope (Steeper than 3:1) – 150 lbs per acre	
Tall fescue	72
Red top grass	2
Seasonal nurse crop[1]	13
Crownvetch[2]	13

[1]Use seasonal nurse crop in accordance with seeding dates as stated below:

February 16 through April .... annual rye
May 1 through August 15 .... foxtail millet
August 16 through October .... annual rye
November through February .... winter rye

[2]Substitute Sericea lespedeza for crownvetch east of Farmville, VA (May through September use hulled Sericea, all other periods, use unhulled Sericea). If flatpea is used in lieu of crownvetch, increase rate to 20% of mixture.
All legume seed must be properly inoculated. Weeping lovegrass may be added to any slope or low-maintenance mix during warmer seeding periods; add 10-20 lbs/acre in mixes.

Note: For all areas apply mulch (straw) at a rate of 1.5 to 2 tons per acre
(minimum 2 tons per acre from November through February)

Table 2e - Site-Specific Seed Mixtures for Coastal Plain Area	
Seed Type	**Total (lbs per acre)**
Minimum Lawn Care (Commercial or Residential)	
Turf-type tall fescue **OR**	175-200
Common Bermudagrass	75
High-Maintenance Lawn	
Turf-type tall fescue **OR**	200-250
Hybrid Bermudagrass (seed[1]) **OR**	40 (unhulled), 30 (hulled)
Hybrid Bermudagrass (by other vegetative establishment method, see Std. & Spec. 3.34)	--
General Slope (3:1 or less)	
Tall fescue	128
Red top grass	2
Seasonal nurse crop[2]	20
Low-Maintenance Slope (Steeper than 3:1)	
Tall fescue	93-108
Common Bermudagrass	0-15
Redtop grass	2
Seasonal nurse crop[2]	20
Sericea lespedeza[1]	20

[1] May through October, use hulled seed. All other seeding periods, use unhulled seed. Weeping lovegrass may be added to any slope or low-maintenance mix during warmer seeding periods; add 10-20 lbs/acre in mixes.

[2] Use seasonal nurse crop in accordance with seeding dates as stated below:

February/March through April .... annual rye
May 1 through August .... foxtail millet
September/October through November 15 .... annual rye
November 16 through January .... winter rye

Note: For all areas apply mulch (straw) at a rate of 1.5 to 2 tons per acre (minimum 2 tons per acre from November through February)

Table 2f - Lime/Fertilizer Application Rates	
Lime[1]	
Coastal Plain Area	2 tons/acre pulverized limestone (90lbs/1000 ft^2)
Piedmont and Appalachian Areas	2 tons/acre pulverized limestone (90lbs/1000ft^2)
Fertilizer – All Areas	
Mixed grasses and legumes	10-20-10 fertilizer applied at a rate of 500lbs/acre
Legume stands only	Apply the equivalent of 100lbs of phosphate and 100lbs of Potash per acre. NO NITROGEN.
Grass stands only	10-20-10 fertilizer[2] applied at a rate of 500lbs/acre.

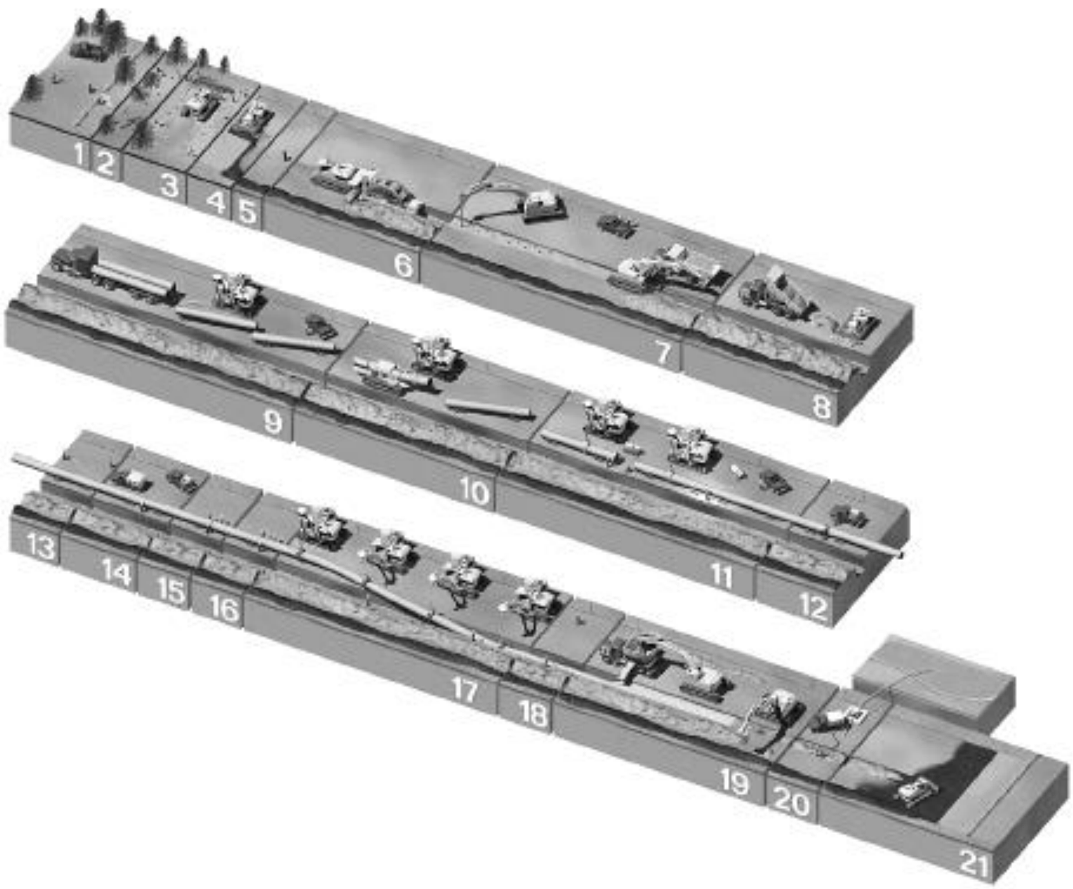
[1]An agricultural grade of limestone should always be used.

[2]Other fertilizer formulations, including slow-release sources of nitrogen (preferred from a water quality standpoint) may be used, provided they can supply the same amounts and proportions of plant nutrients.

Note: Lime and fertilizer shall be incorporated into the top 4-6 inches of the soil by disking or other means wherever possible. For erosion control, when applying lime and fertilizer with a hydroseeder, apply to a rough, loose surface.

XII. Figures

Figure 1 – Typical Pipeline Construction Sequence

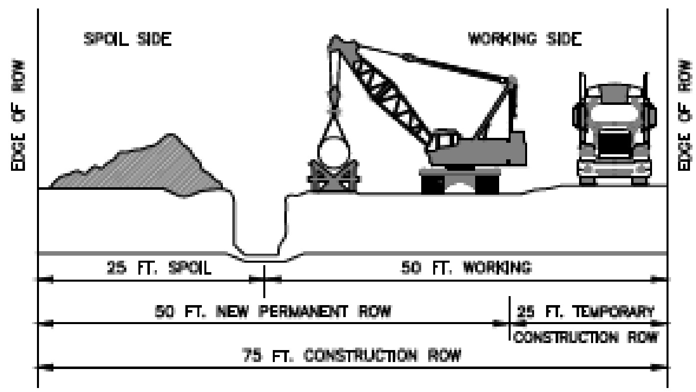


1. SURVEY AND STAKING
2. CLEARING
3. FRONT–END–GRADING
4. ROW TOPSOIL STRIPPING
5. RESTAKING CENTERLINE OF TRENCH
6. TRENCHING (WHEEL DITCHER)
7. TRENCHING (ROCK)
8. PADDING TRENCH BOTTOM
9. STRINGING PIPE
10. FIELD BENDING PIPE
11. LINE–UP, INITIAL WELD
12. FILL & CAP, FINAL WELD
13. AS–BUILT FOOTAGE
14. X–RAY INSPECTION, WELD REPAIR
15. COATING FIELD WELDS
16. INSPECTION & REPAIR OF COATING
17. LOWERING PIPE INTO TRENCH
18. AS–BUILT SURVEY
19. PAD, BACKFILL, ROUGH GRADE
20. HYDROSTATIC TESTING, FINAL TIE IN
21. REPALCE TOPSOIL, FINAL CLEAN–UP, FULL RESTORATION

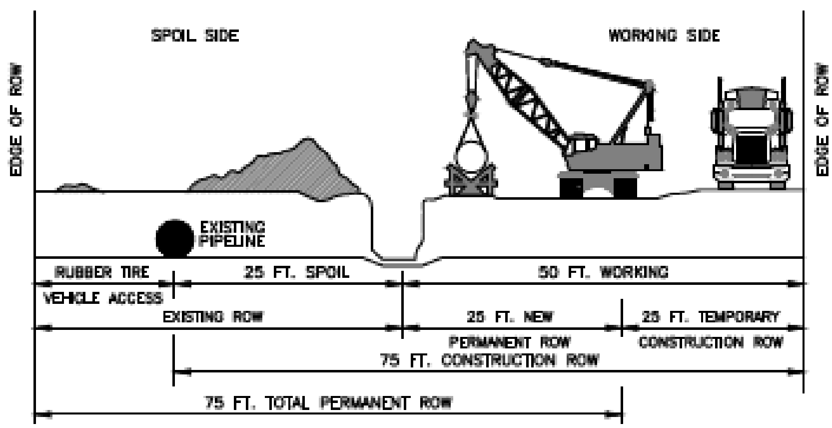
NOT TO SCALE

TC Energy	TYPICAL PIPELINE CONSTRUCTION SEQUENCE	FIGURE NO. 1

Figure 2 – Typical 75 ft. Construction Right-of-Way



NEW ROW



PARALLEL TO EXISTING ROW

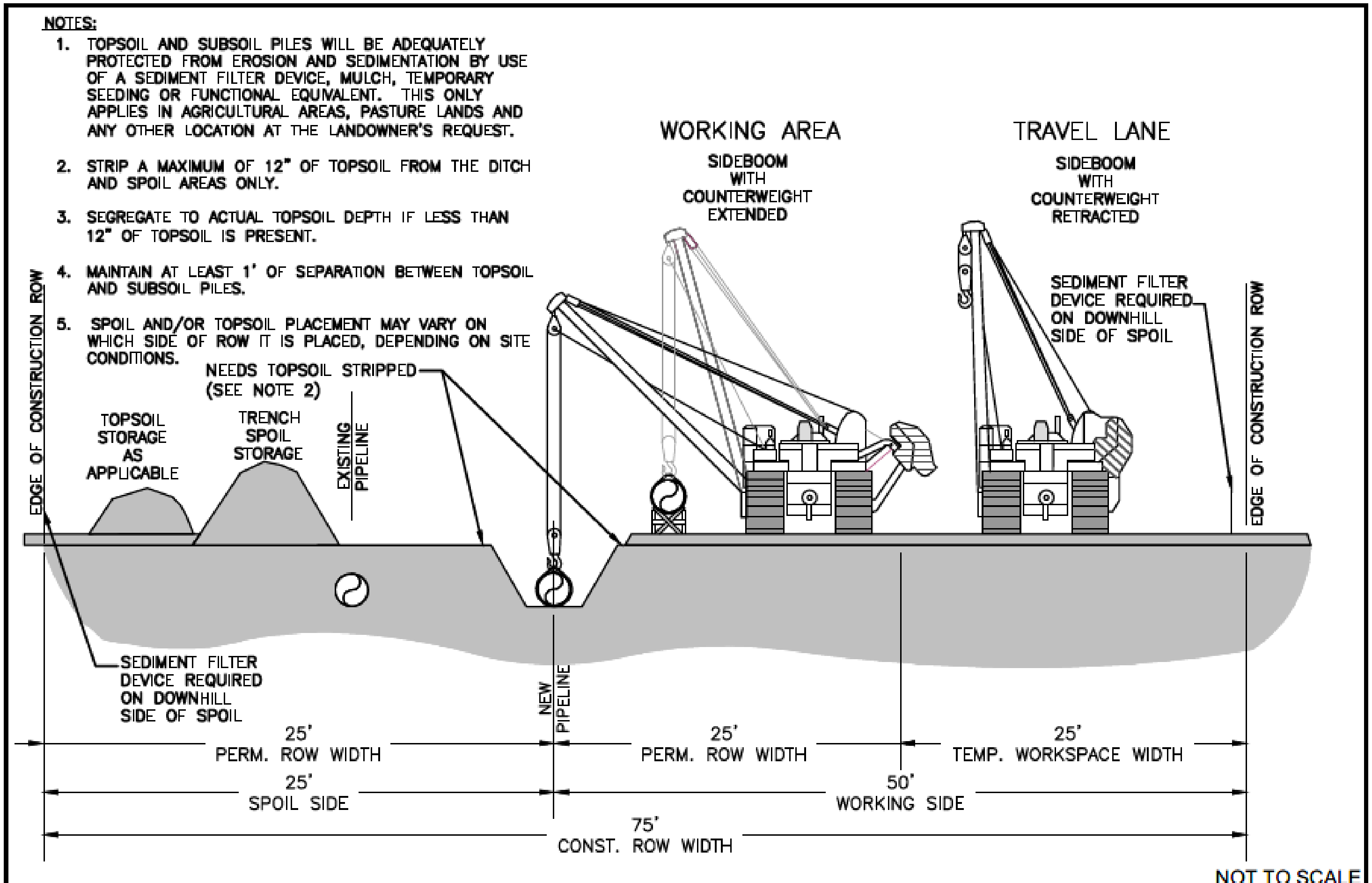
NOTES:

1. USE FOR 14–INCH OR GREATER DIAMETER PIPELINE.
2. THE DIMENSIONS SHOWN ON THIS FIGURE ARE TYPICAL.
3. VARIATIONS FOR STAGING AREAS MAY BE NECESSARY DUE TO SITE–SPECIFIC TERRAIN FEATURES; HOWEVER, UNLESS OTHERWISE INDICATED IN COLUMBIA'S ENVIRON–MENTAL MANAGEMENT & CONSTRUCTION PLANS, THE MAXIMUM WIDTH OF CONSTRUCTION ROW WILL BE 75 FEET.

NOT TO SCALE

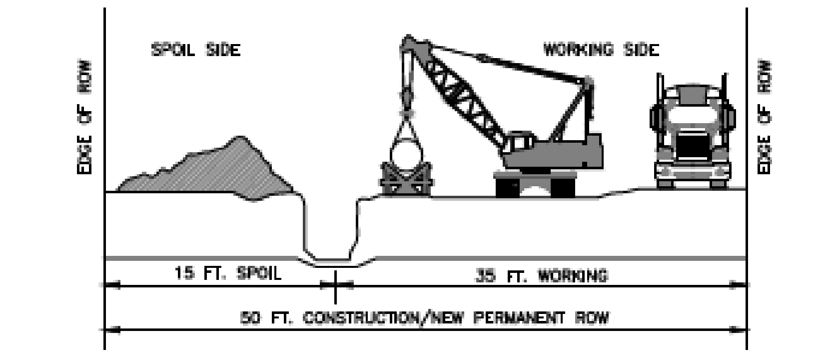
TC Energy	TYPICAL 75 FT. CONSTRUCTION RIGHT-OF-WAY	FIGURE NO. 2

Figure 3 – Typical ROW Configuration Abut Existing Pipelines with Temporary Overlap

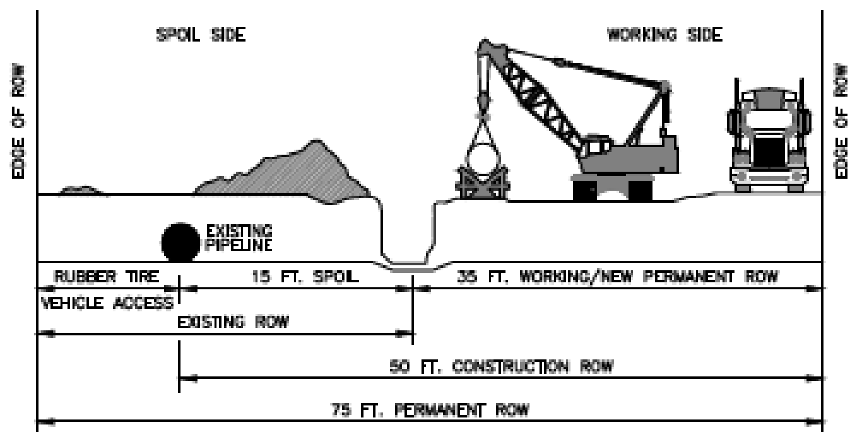


TC Energy	TYPICAL ROW CONFIGURATION ABUT EXISTING PIPELINES WITH TEMPORARY OVERLAP	FIGURE NO. 3

Figure 4 – Typical 50 ft. Construction Right-of-Way



NEW ROW



PARALLEL TO EXISTING ROW

NOTES:

1. USE FOR 12–INCH OR LESS DIAMETER PIPELINE.
2. THE DIMENSIONS SHOWN ON THIS FIGURE ARE TYPICAL.
3. VARIATIONS FOR STAGING AREAS MAY BE NECESSARY DUE TO SITE–SPECIFIC TERRAIN FEATURES; HOWEVER, UNLESS OTHERWISE INDICATED IN TC ENERGY'S ENVIRON–MENTAL MANAGEMENT & CONSTRUCTION PLANS, THE MAXIMUM WIDTH OF CONSTRUCTION ROW WILL BE 50 FEET.

NOT TO SCALE

TC Energy	TYPICAL 50 FT. CONSTRUCTION RIGHT-OF-WAY	FIGURE NO. 4

Figure 5 – Typical 50’ ROW Configuration Topsoil Segregation

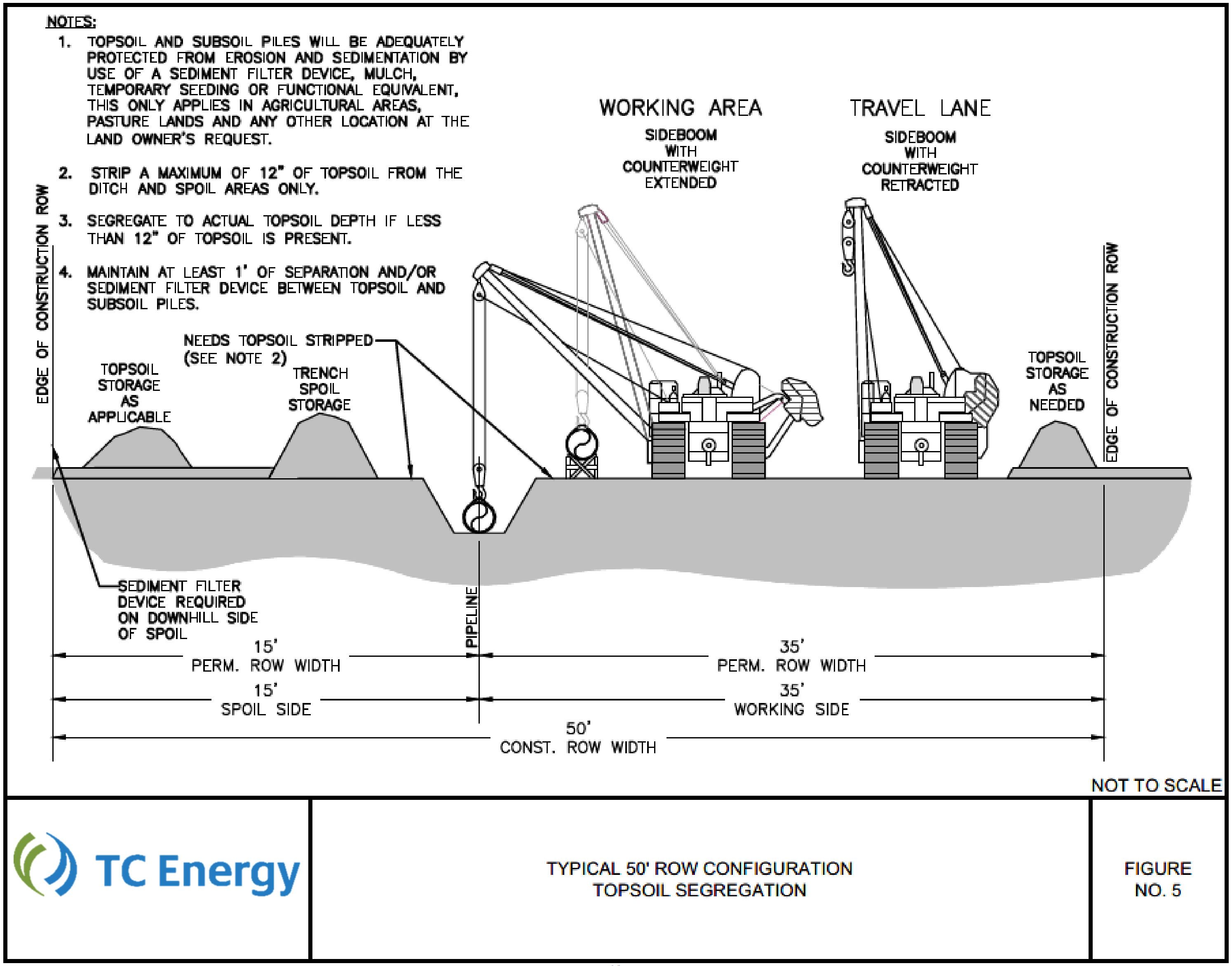
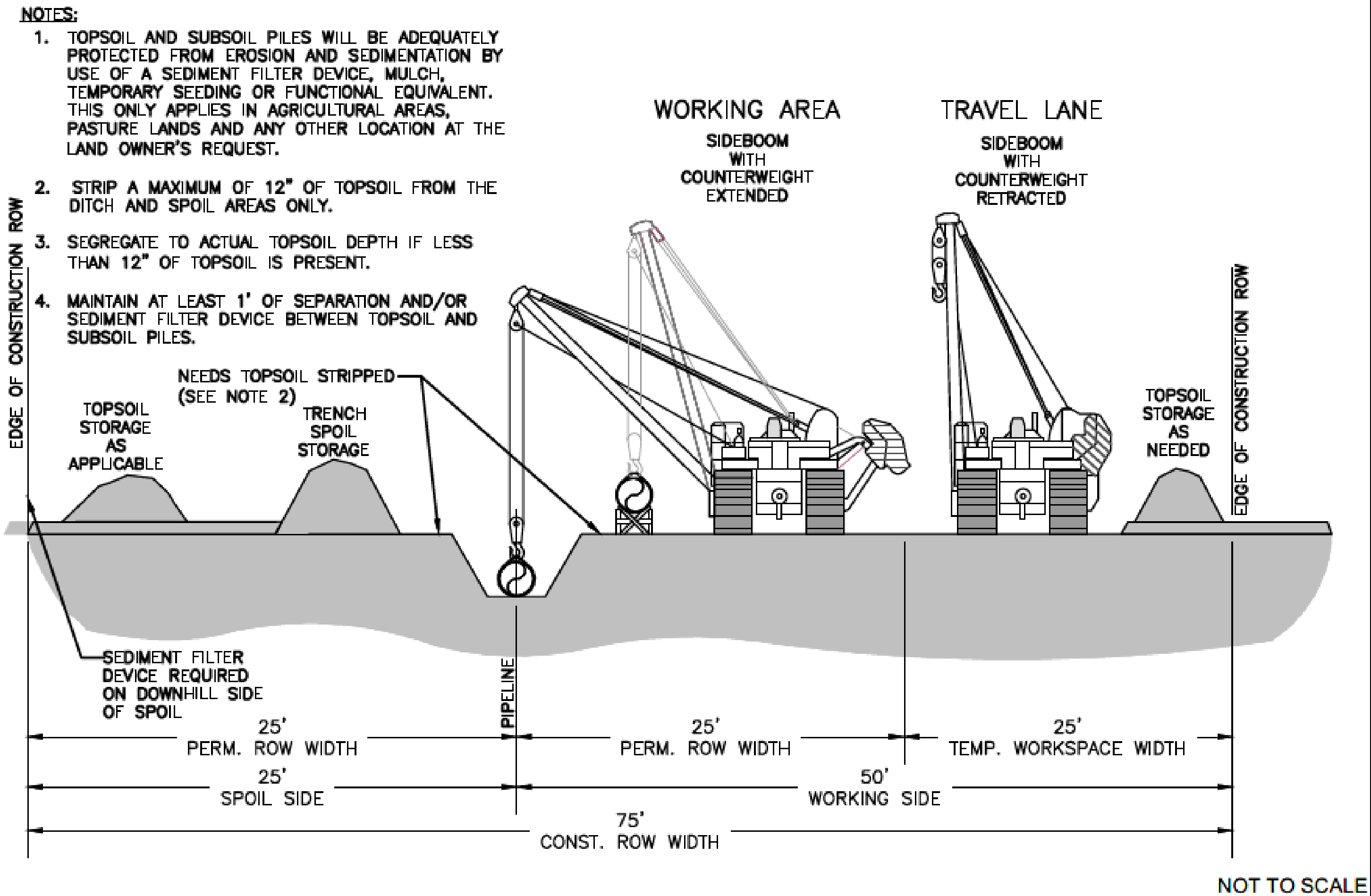


Figure 6 – Typical 75' ROW Configuration Topsoil Segregation

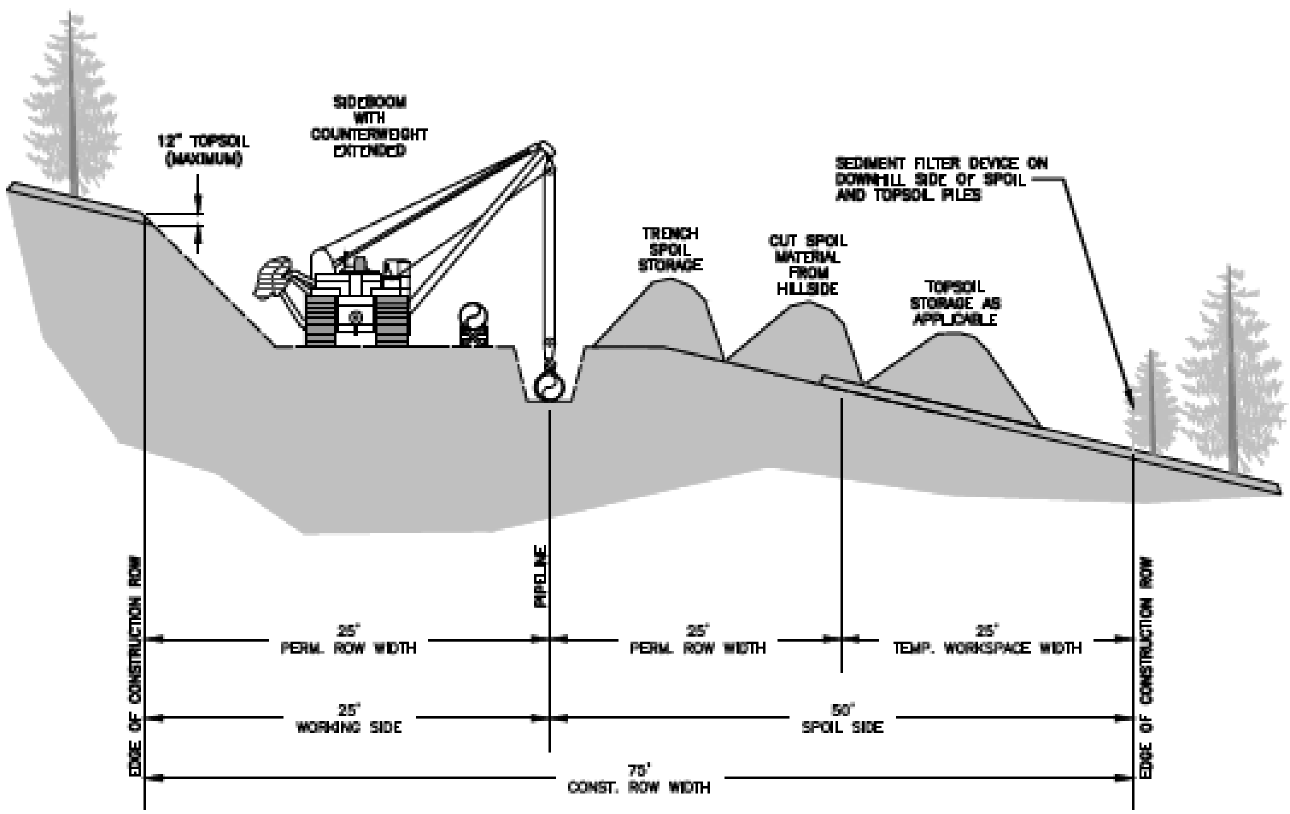


TC Energy

TYPICAL 75' ROW CONFIGURATION
TOPSOIL SEGREGATION

FIGURE NO. 6

Figure 7 – Side Hill Construction



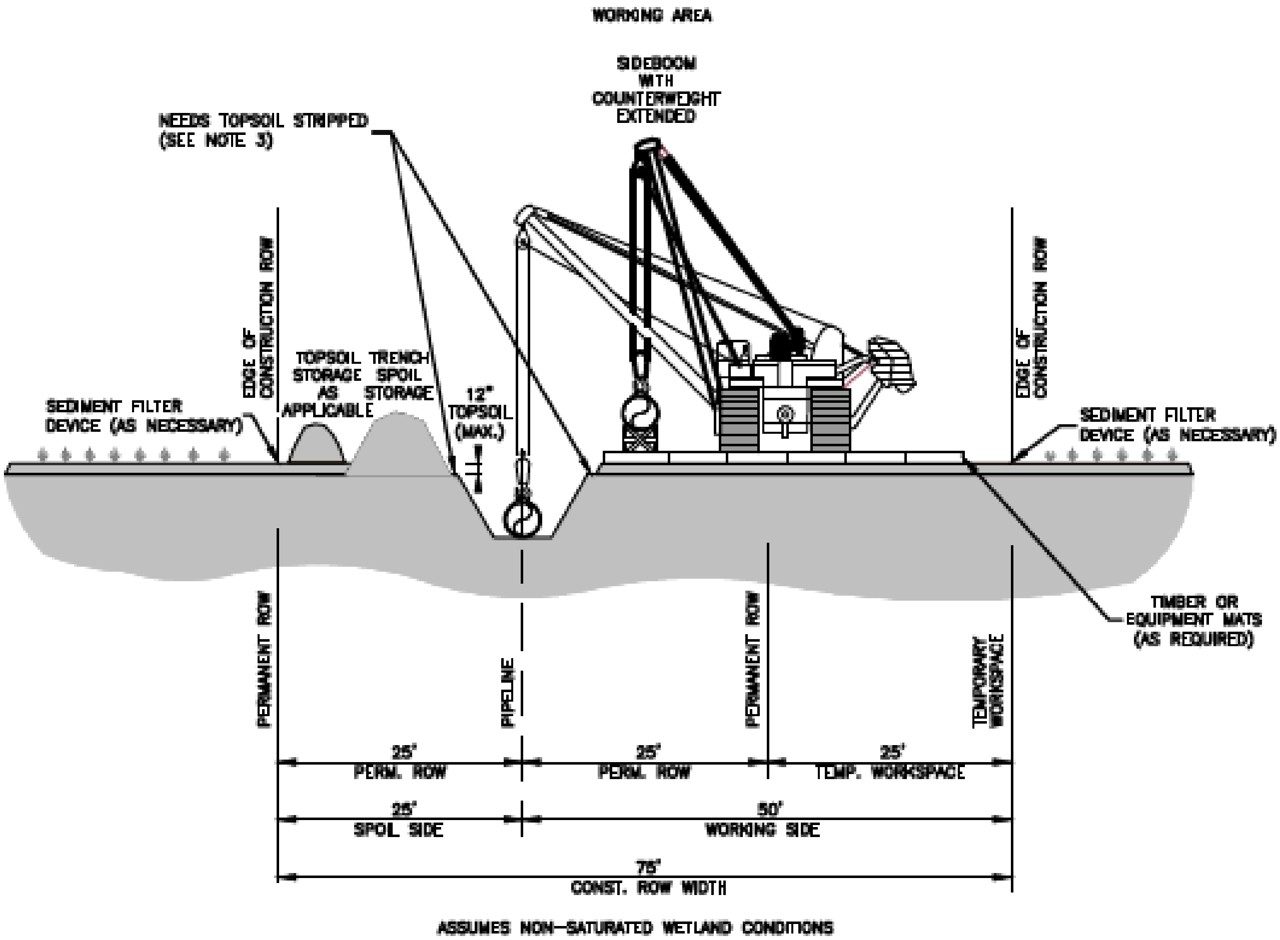
NOTES:

1. TOPSOIL AND SUBSOIL PILES WILL BE ADEQUATELY PROTECTED FROM EROSION AND SEDIMENTATION BY USE OF A SEDIMENT FILTER DEVICE, MULCH, TEMPORARY SEEDING OR FUNCTIONAL EQUIVALENT. THIS ONLY APPLIES IN AGRICULTURAL AREAS, PASTURE LANDS AND ANY OHTER LOCATION AT THE LAND OWNER'S REQUEST.
2. STRIP A MAXIMUM OF 12" OF TOPSOIL ACROSS THE ENTIRE CONSTRUCTION ROW WHERE SOIL SEGREGATION IS APPLICABLE.
3. SEGREGATE TO ACTUAL TOPSOIL DEPTH IF LESS THAN 12" OF TOPSOIL IS PRESENT.
4. MAINTAIN AT LEAST 1' OF SEPARATION BETWEEN TOPSOIL AND SUBSOIL PILES.

NOT TO SCALE

TC Energy	SIDE HILL CONSTRUCTION	FIGURE NO. 7

Figure 8 – Typical Wetland ROW Configuration



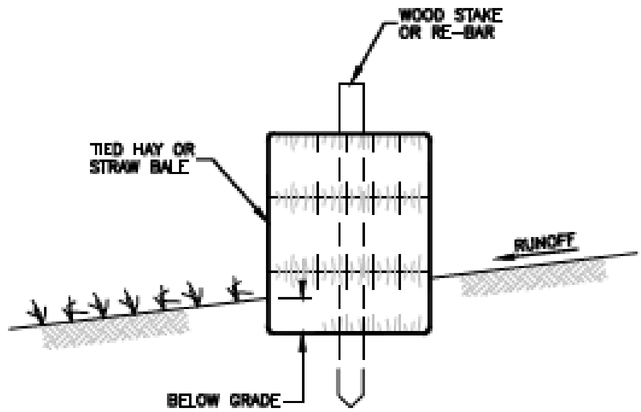
NOTES:

1. A SEDIMENT FILTER DEVICE WILL BE PLACED ACROSS THE ROW AT THE WETLAND'S EDGE, IMMEDIATELY UPSLOPE FROM THE WETLAND BOUNDARY.
2. A SEDIMENT FILTER DEVICE WILL BE PLACED AT THE DOWNSLOPE AND UPSLOPE EDGES (BOXED IN) OF THE ROW AND SOIL AND SPOIL PILES AS NECESSARY.
3. STRIP A MAXIMUM OF 12" OF TOPSOIL ACROSS THE DITCHLINE ONLY.
4. MAINTAIN AT LEAST 1' OF SEPARATION BETWEEN TOPSOIL AND SUBSOIL PILES.

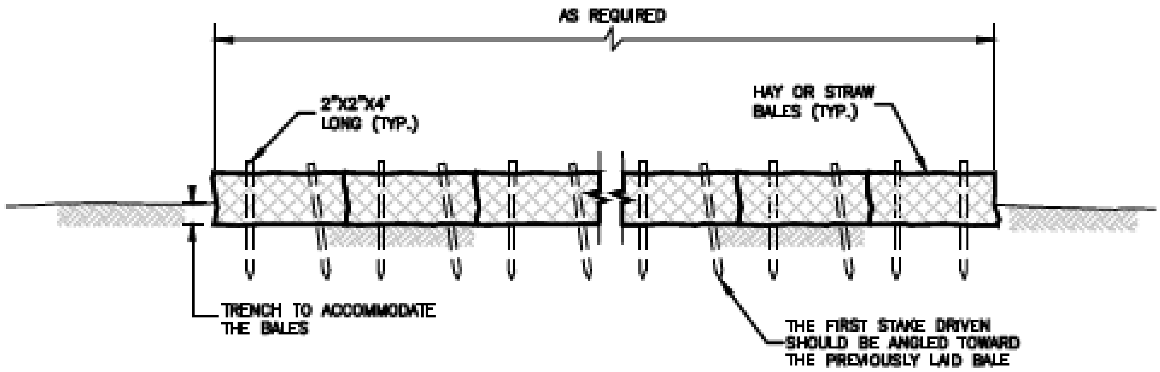
NOT TO SCALE

TC Energy	TYPICAL WETLAND ROW CONFIGURATION	FIGURE NO. 8

Figure 9 – Typical Straw or Hay Bale Barrier



SECTION



SECTION

NOTES:

1) TO ELIMINATE POSSIBLE END FLOW, BOTH ENDS OF THE STRAW BALE BARRIER SHOULD BE TURNED AND EXTENDED UPSLOPE.

2) EACH BALE SHOULD BE SECURED BY AT LEAST 2 STAKES. THE FIRST STAKE IN EACH BALE SHALL BE DRIVEN TOWARD THE PREVIOUSLY LAID BALE TO FORCE THE BALES TOGETHER. ANY GAPS CAN BE FILLED IN BY WEDGING LOOSE STRAW BETWEEN THE BALES. STAKES SHOULD BE DRIVEN. REBAR OR STANDARD "T" OR "U" STEEL POSTS CAN BE USED AS STAKES, BUT IT SHOULD BE NOTED THAT THEY MAY POSE A HAZARD TO EQUIPMENT IF THE BALES DISINTEGRATE.

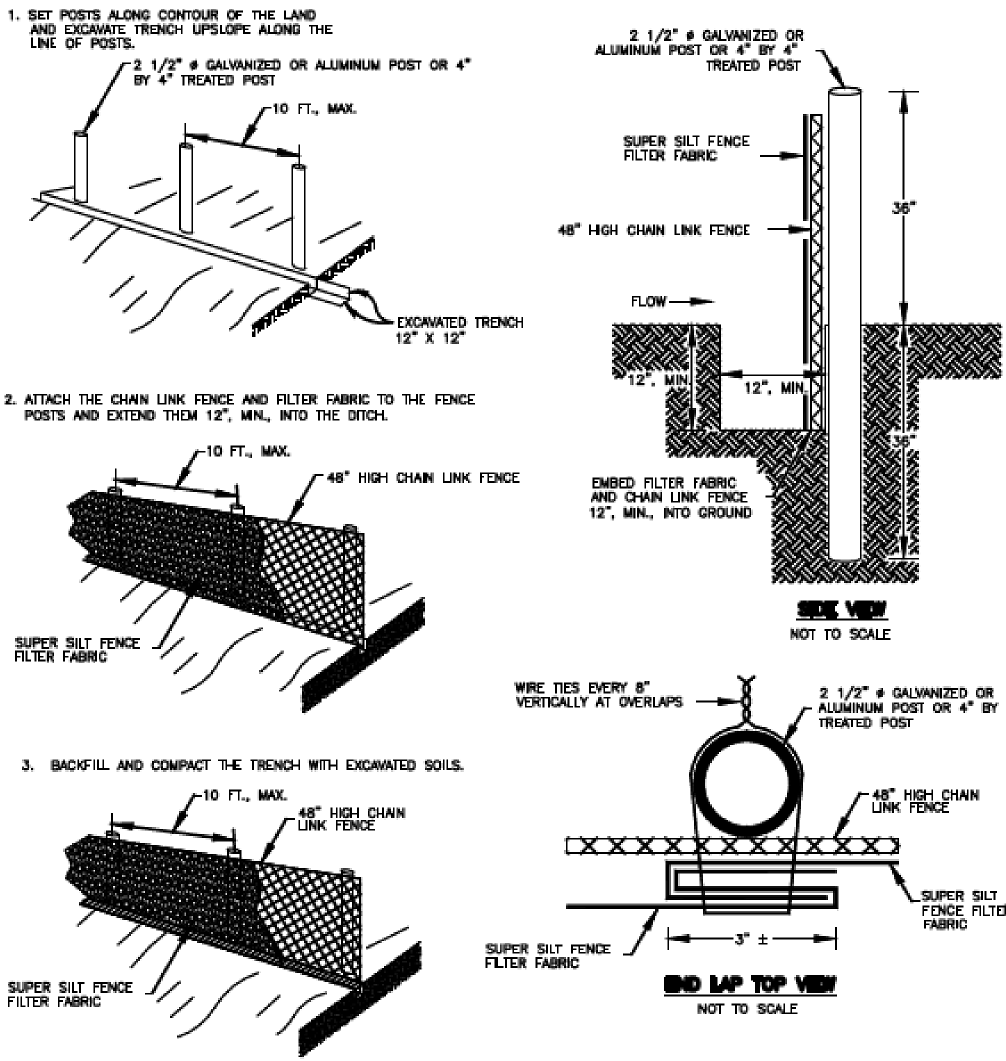
3) COMPACT THE EXCAVATED SOIL AGAINST THE UPHILL SIDE OF THE BARRIER TO PREVENT PIPING.

4) INSTALLATION TO BE MODIFIED BY THE PROJECT AS NECESSARY TO SUIT ACTUAL SITE CONDITIONS.

NOT TO SCALE

TC Energy	TYPICAL STRAW OR HAY BALE BARRIER	FIGURE NO. 9

Figure 10 – Sediment Filter Device Super Silt Fence



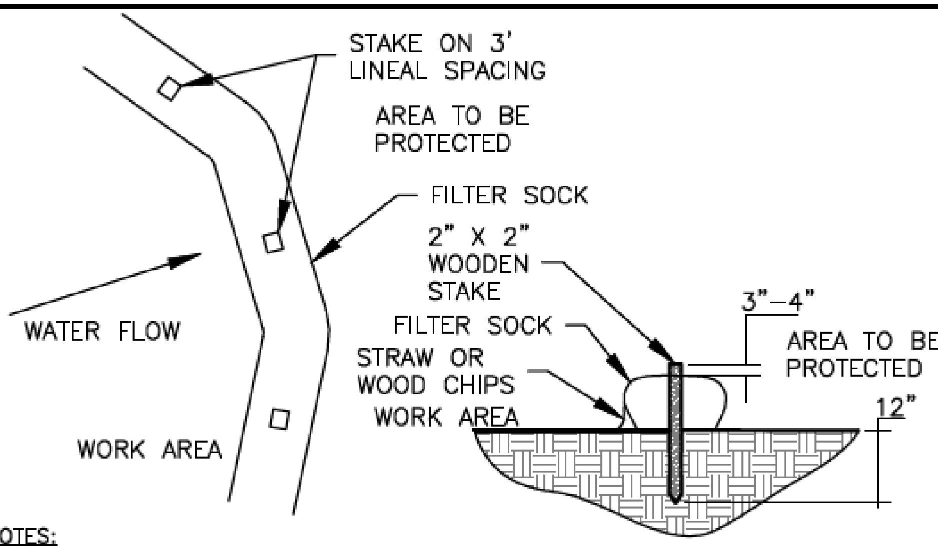
SUPER SILT FENCE NOTES:

1. USE OF CHAIN LINK FENCING SHALL BE PROPERLY CONSTRUCTED AND FASTENED SECURELY TO THE POSTS WITH WIRE TIES OR STAPLES.
2. POSTS NEED NOT BE SET IN CONCRETE.
3. THE FILTER FABRIC SHALL BE FASTENED TO THE CHAIN LINK FENCE WITH TIES EVERY 24" AT THE TOP AND MID SECTION.
4. FABRIC AND FENCE SHALL BE EMBEDDED 12", MINIMUM, INTO THE GROUND.
5. A 6", MINIMUM, OVERLAP SHALL BE PROVIDED WHERE TWO SECTIONS OF FABRIC ADJOIN. THE OVERLAPPED FABRIC SHALL BE FOLDED TOGETHER AND ATTACHED TO THE CHAIN LINK FENCE.
6. 4" BY 4" PRESSURE TREATED POSTS MAY BE SUBSTITUTED FOR METAL FENCE POSTS WITH THE APPROVAL OF THE CHIEF INSPECTOR OR ENVIRONMENTAL INSPECTOR.
7. THE LENGTH OF SLOPE ABOVE THE FENCE SHALL NOT EXCEED 400 FEET IN STEEP TERRAIN. IN FLATTER AREAS THE LENGTH CAN BE EXTENDED WITH THE APPROVAL OF THE CHIEF INSPECTOR OR ENVIRONMENTAL INSPECTOR.

NOT TO SCALE

TC Energy	SEDIMENT FILTER DEVICE SUPER SILT FENCE	FIGURE NO. 10

Figure 11 – Typical Compost Filter Sock



NOTES:

1. COMPOST FILTER SOCK TO BE FILTREXX SILTSOXX OR APPROVED EQUIVALENT.
2. THE ADJOINING ENDS OF SECTIONS OF COMPOST FILTER SOCK SHOULD OVERLAP 1' AND BE STAKED.
3. 8", 12" 18" AND 24" COMPOST FILTER SOCK TO BE USED. SEE PLAN SHEET FOR SIZES AND LOCATIONS.
4. ACCUMULATED SEDIMENT SHALL BE REMOVED AND DISPOSED OF WHEN IT REACHES 1/2 THE ABOVE GROUND HEIGHT OF THE COMPOST FILTER SOCK.
5. COMPOST FILTER SOCK SHALL BE INSPECTED WEEKLY AND AFTER EACH RUNOFF EVENT. DAMAGED COMPOST FILTER SOCK SHALL BE REPAIRED ACCORDING TO MANUFACTURER'S SPECIFICATIONS.

FILTER SOCK SIZING CHART

SLOPE PERCENT	8 IN (200 mm) SiltSoxx™	12 IN (300 mm) SiltSoxx™	18 IN (450 mm) SiltSoxx™	24 IN (600 mm) SiltSoxx™	32 IN (800 mm) SiltSoxx™
	6.5 IN (160 mm)**	9.5 IN (240 mm)**	14.5 IN (360 mm)**	19 IN (480 mm)**	26 IN (650 mm)**
2 (OR LESS)	600 (180)	750 (225)	1000 (300)	1300 (400)	1650 (500)
5	400 (120)	500 (150)	550 (165)	650 (200)	750 (225)
10	200 (120)	250 (75)	300 (90)	400 (120)	500 (150)
15	140 (40)	170 (50)	200 (60)	325 (100)	450 (140)
20	100 (30)	125 (38)	140 (42)	260 (80)	400 (120)
25	80 (24)	100 (30)	110 (33)	200 (60)	275 (85)
30	60 (18)	75 (23)	90 (27)	130 (40)	200 (60)
35	60 (18)	75 (23)	80 (24)	115 (35)	150 (45)
40	60 (18)	75 (23)	80 (24)	100 (30)	125 (38)
45	40 (12)	50 (15)	60 (18)	80 (24)	100 (30)
50	40 (12)	50 (15)	55 (17)	65 (20)	75 (23)

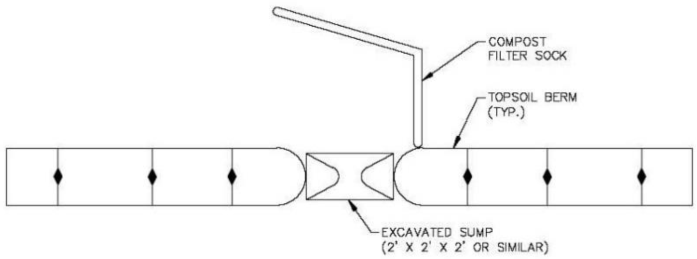
* BASED ON FAILURE POINT OF 36 IN (0.9 m) SUPER SILT FENCE (WIRE REINFORCED) AT 1000 FT. (303 m) OF SLOPE, WATERSHED WIDTH EQUIVALENT TO RECEIVING LENGTH OF SEDIMENT CONTROL DEVICE, 1 IN/24 hr (25 mm/24 hr) RAIN EVENT.

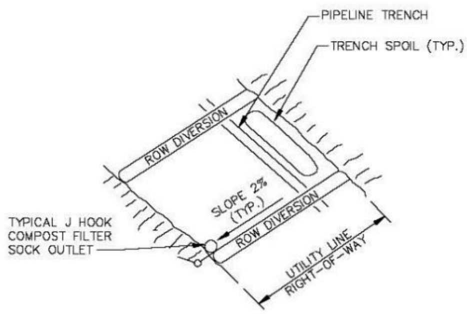
** EFFECTIVE HEIGHT OF SiltSoxx ™AFTER INSTALLATION AND WITH CONSTANT HEAD FROM RUNOFF AS DETERMINED BY OHIO STATE UNIVERSITY.

NOT TO SCALE

TC Energy	TYPICAL COMPOST FILTER SOCK	FIGURE NO. 11

Figure 11A – J-Hook Outlet





PLAN

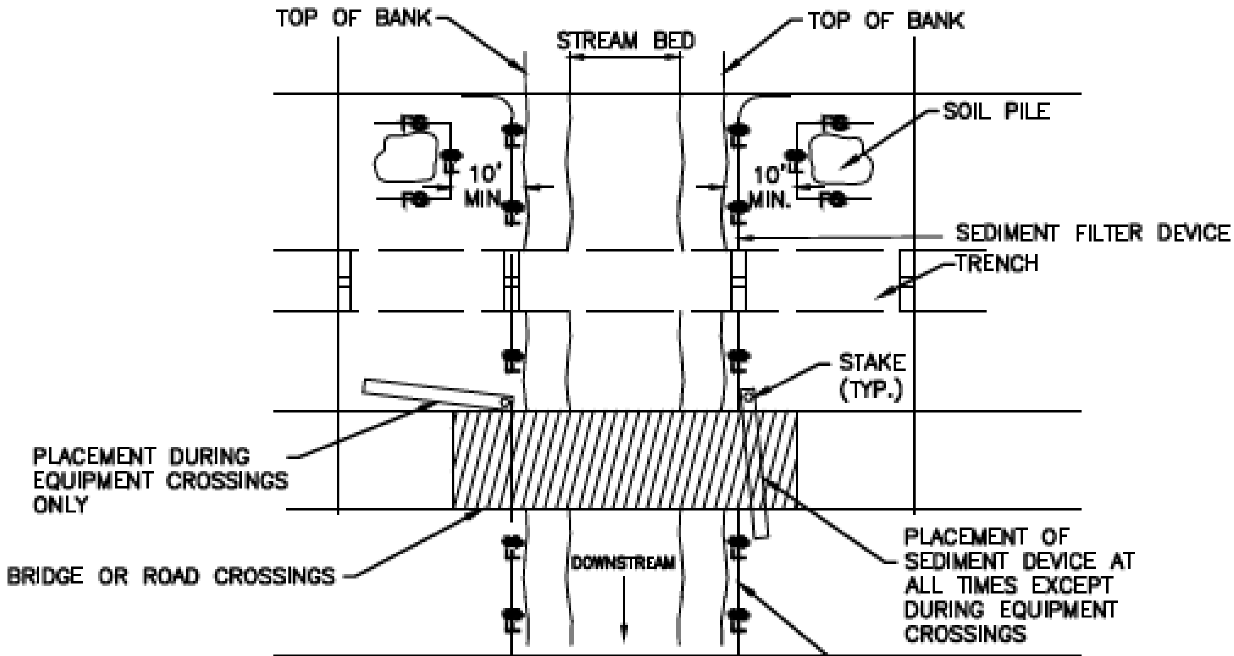
NOTES:

1. REFER TO FIGURE 11 FOR DETAILS ON THE COMPOST FILTER SOCK DESIGN AND INSTALLATION.
2. REFER TO VESCH 3.11 TEMPORARY RIGHT-OF-WAY DIVERSION SPECIFICATION FOR DETAILS ON THE ROW DIVERSION DESIGN AND INSTALLATION.

NOT TO SCALE

TC Energy	J-HOOK OUTLET	FIGURE NO. 11A

Figure 12 – Typical Removable Sediment Filter Device



PLAN VIEW

NOTES:

1. SEDIMENT FILTER DEVICE (COMPOST FILTER SOCK, SILT FENCE OR OTHER APPROVED EQUIVALENT.) SHALL BE INSPECTED WEEKLY AND AFTER EACH RUNOFF EVENT. DAMAGED SEDIMENT FILTER DEVICE SHALL BE REPAIRED ACCORDING TO MANUFACTURER'S SPECIFICATIONS.

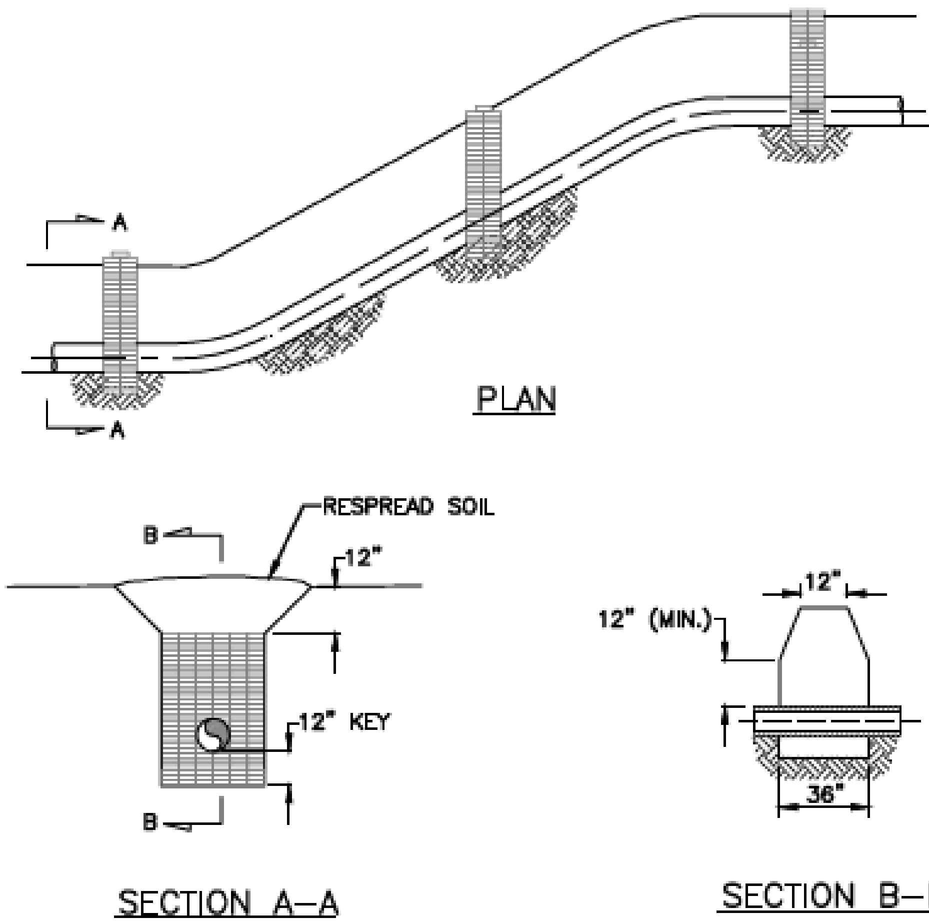
2. SEDIMENT FILTER DEVICE AT ENTRANCES SHALL BE IN PLACE FROM START OF DAY. DURING CONSTRUCTION ACTIVITIES AND AT END OF DAY. SEDIMENT FILTER DEVICE MAY BE TEMPORARILY MOVED AS SHOWN ON THE LEFT DURING EQUIPMENT CROSSING ACTIVITIES BUT MUST BE REPLACED IMMEDIATELY UPON COMPLETION OF CROSSING.

3. COMPOST FILTER SOCK TO BE FILTREXX SILTSOXX OR APPROVED EQUIVALENT.

NOT TO SCALE

TC Energy	TYPICAL REMOVABLE SEDIMENT FILTER DEVICE	FIGURE NO. 12

Figure 13 – Typical Permanent Trench Breaker



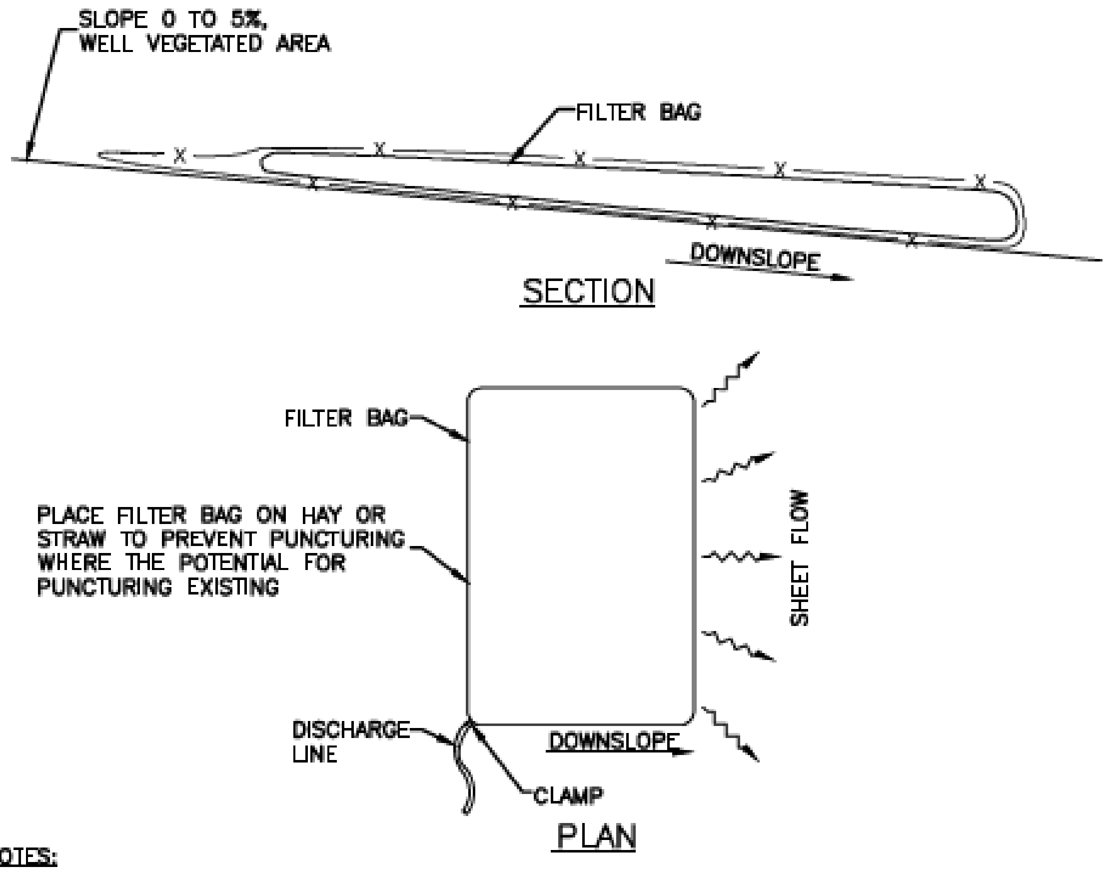
NOTES:

1. TRENCH BREAKERS TO BE INSTALLED AS SHOWN ON THE CONSTRUCTION DRAWINGS, WHERE DESCRIBED IN THE PLAN, AND AS DIRECTED.
2. KEY EACH TRENCH BREAKER A MINIMUM OF ONE (1) FT. INTO BOTTOMS AND SIDES OF TRENCH.
3. FOAM TRENCH BREAKERS MAY BE USED IN LIEU OF SAND SACK TRENCH BREAKERS.
4. INSTALL JUST UPSLOPE OF EVERY PERMANENT ROW DIVERSION/SLOPE BREAKER PROMPTLY AS TRENCH IS COMPLETED.
5. INSTALLATION SPECIFICATIONS TO BE MODIFIED AS NECESSARY TO SUIT ACTUAL SITE CONDITIONS.
6. TRENCH BREAKER SHALL BE INSTALLED SUCH THAT THE TOP OF EACH DOWNSLOPE BREAKER IS AT OR ABOVE THE BOTTOM OF THE NEXT UPSLOPE BREAKER.
7. INSTALL TRENCH BREAKER AT THE BASE OF SLOPES GREATER THAN 5% WHERE THE BASE OF THE SLOPE IS LESS THAN 50' FROM A WATER BODY OR WETLAND AND WHERE NEEDED TO AVOID DRAINING A WATER BODY OR WETLAND.

NOT TO SCALE

TC Energy	TYPICAL PERMANENT TRENCH BREAKER	FIGURE NO. 13

Figure 14 – Typical Dewatering Filter Bag



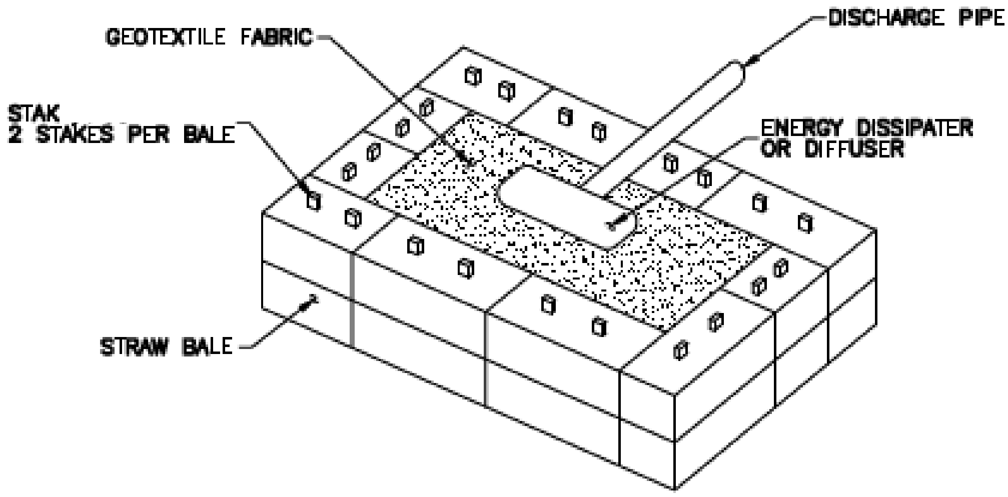
NOTES:

1. MANUFACTURED NON–WOVEN (FELT) FILTER BAGS ARE A SUITABLE ALTERNATIVE TO STRAW BALE STRUCTURES FOR TRENCH DEWATERING. FILTER BAGS SHALL BE INSTALLED AS SPECIFIED BY THE MANUFACTURER.
2. INSTALLATION SPECIFICATIONS TO BE MODIFIED AS NECESSARY TO SUIT ACTUAL SITE CONDITIONS.
3. THE PUMP DISCHARGE HOSE SHALL BE INSERTED INTO THE BAGS IN THE MANNER SPECIFIED BY THE MANUFACTURER AND SECURELY CLAMPED. ONLY ONE PUMP DISCHARGE HOSE SHOULD BE USED PER BAG UNLESS BAG IS SPECIFICALLY MANUFACTURED TO ACCEPT MORE THAN ONE.
4. DO NOT ALTER OR CUT BAGS.
5. BAGS CANNOT BE ACCESSED BY EQUIPMENT UNLESS IT CAN BE REACHED FROM WITHIN THE PERMITTED WORKSPACE.
6. BAGS WILL BE REPLACED WHEN THEY BECOME 1/2 FULL OF SEDIMENT.
7. ADDITIONAL SEDIMENT AND EROSION CONTROLS MAY NEED TO BE INSTALLED AROUND THE FILTER BAG, AS APPROPRIATE, AND APPROVED BY THE ENVIRONMENTAL INSPECTOR.

NOT TO SCALE

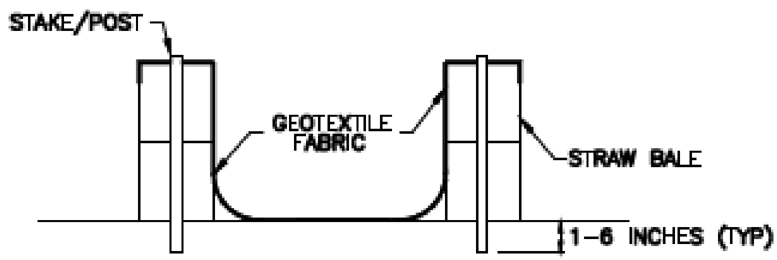
TC Energy	TYPICAL DEWATERING FILTER BAG	FIGURE NO. 14

Figure 15 – Hydrostatic Test Dewatering Pit



ISOMETRIC VIEW

NOT TO SCALE



PROFILE VIEW

NOT TO SCALE

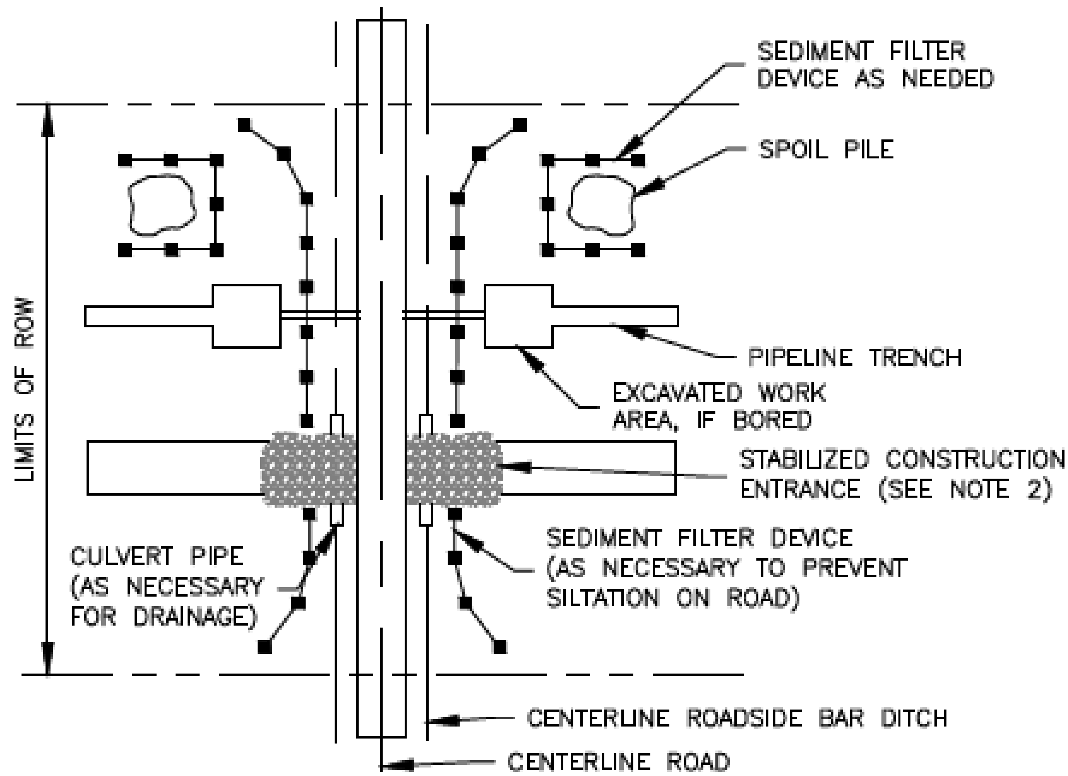
NOTES:

1. ALL DEWATERING ACTIVITIES WILL BE CONDUCTED IN ACCORDANCE WITH PERMIT CONDITIONS.
2. DISCHARGE SITE SHOULD BE WELL VEGETATED, WHERE POSSIBLE, AND LOCATED AT LEAST 50FT FROM ANY WATERBODY. THE TOPOGRAPHY OF THE SITE SHOULD BE SUCH THAT WATER WILL FLOW INTO THE DEWATERING STRUCTURE AND AWAY FROM ANY WORK AREAS.
3. DIRECT THE PUMPED WATER ONTO A STABLE SPILL PAD CONSTRUCTED OF STRAW BALES OR GEOTEXTILE FABRIC STAKED TO THE GROUND SURFACE.
4. DISCHARGE RATES SHOULD BE SUCH THAT THE STRUCTURE WILL NOT OVERFLOW.
5. DRIVE TWO STAKES OR POSTS INTO EACH BALE TO ANCHOR THEM IN PLACE.
6. FILTER BAGS ARE A SUITABLE ALTERNATIVE TO STRAW BALE STRUCTURES FOR TRENCH DEWATERING. STRAW BALES OR FILTER SOCK CAN BE ADDED AROUND THE FILTER BAG TO PROVIDE ADDITIONAL SEDIMENT CONTROL WHERE NEEDED.
7. STAKES OR POSTS SHOULD BE 2X2 WOOD OR SUITABLE ALTERNATIVE.
8. SIZE OF DEWATERING STRUCTURE WILL BE DETERMINED BASED ON VOLUME OF DISCHARGE.

NOT TO SCALE

TC Energy	HYDROSTATIC TEST DEWATERING PIT	FIGURE NO. 15

Figure 16 – Typical Erosion Control Measures at Road Crossings



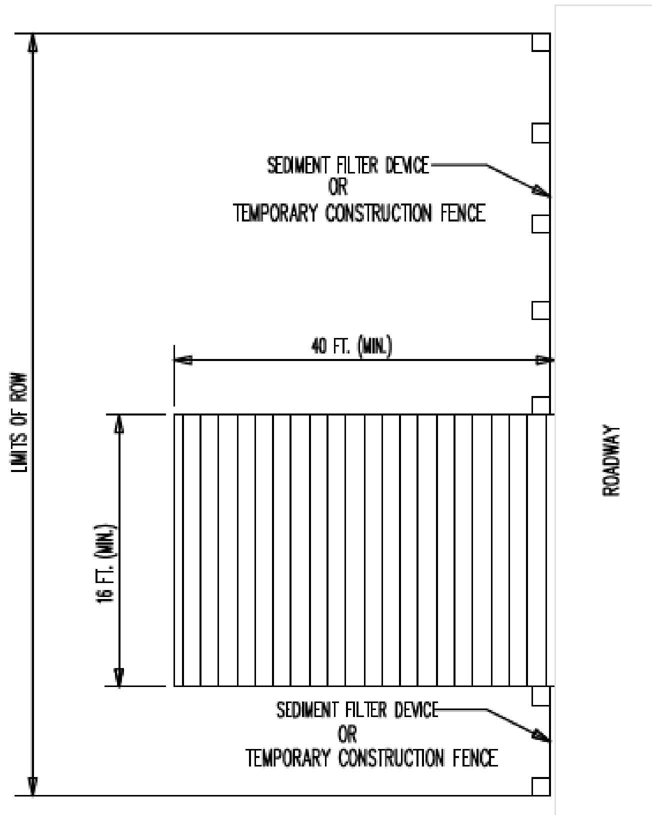
NOTES:

1. SIMILAR PROCEDURES WILL BE USED AT STABILIZED CONSTRUCTION ENTRANCES.
2. REFER TO FIGURE 17 AND VESCH 3.02 STONE CONSTRUCTION ENTRANCE FOR TYPES OF ROAD ENTRANCES.

NOT TO SCALE

TC Energy	TYPICAL EROSION CONTROL MEASURES AT ROAD CROSSINGS	FIGURE NO. 16

Figure 17 – Temporary Road Entrance Board Road Right-of-Way



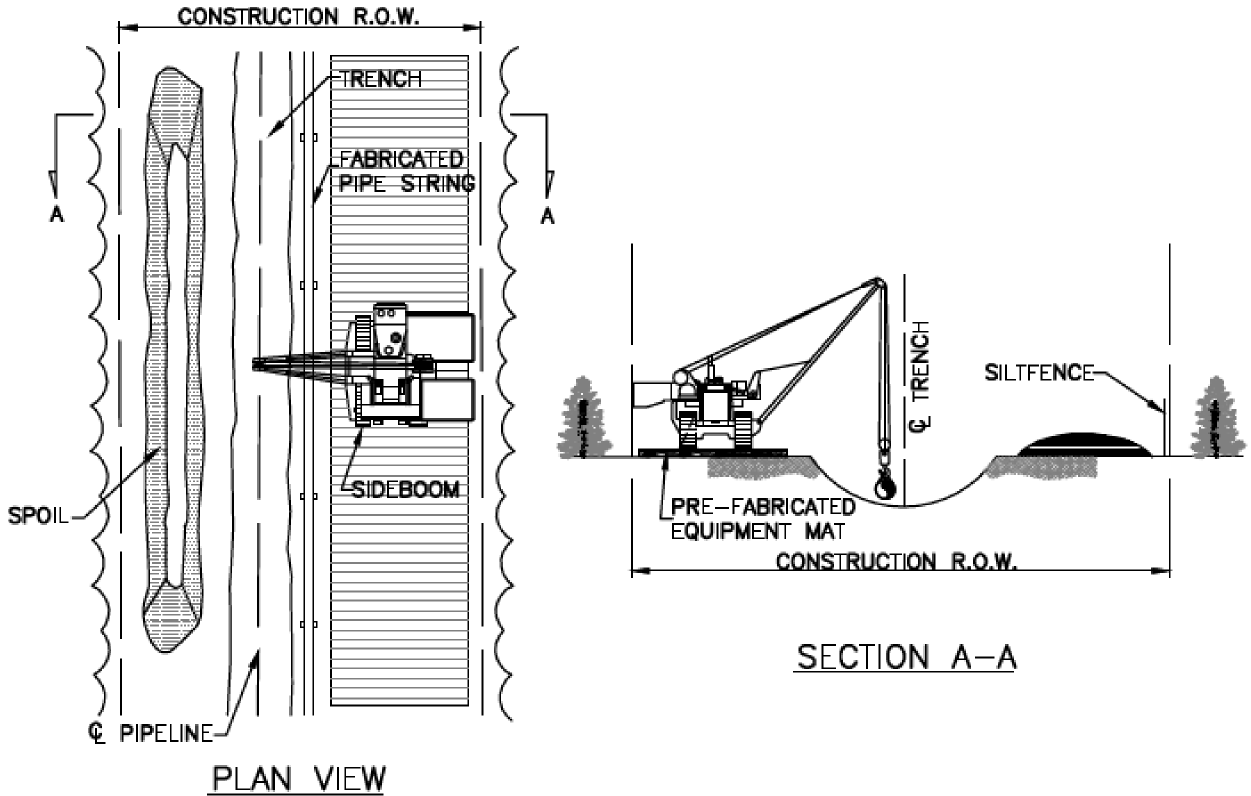
NOTES:

1. BOARD ROADS TO BE USED IN WETLANDS AND ROAD– WAY ENTRANCES FOR TEMPORARY ACCESS ROADS.
2. BOARD ROADS ARE CONSTRUCTED BY LAYERING A BASE OF THE INTERLOCKING MATS PARALLEL TO THE ROAD IN A STAGGERED MANNER. OTHER METHODS OF BOARD ROAD CONSTRUCTION CAN BE USED IF APPROVED BY THE ENVIRONMENTAL AFFAIRS, CONSTRUCTION DEPARTMENT.
3. BOARD ROADS WILL BE UNDERLAIN WITH GEOTEXTILE FABRIC WHERE REQUIRED.
4. BOARD ROADS SHOULD BE MAINTAINED SO AS NOT TO ALLOW EXCESS MUD TO ACCUMULATE.

NOT TO SCALE

TC Energy	TEMPORARY ROAD ENTRANCE BOARD ROAD RIGHT-OF-WAY	FIGURE NO. 17

Figure 18 – Standard Wetland Crossing Method



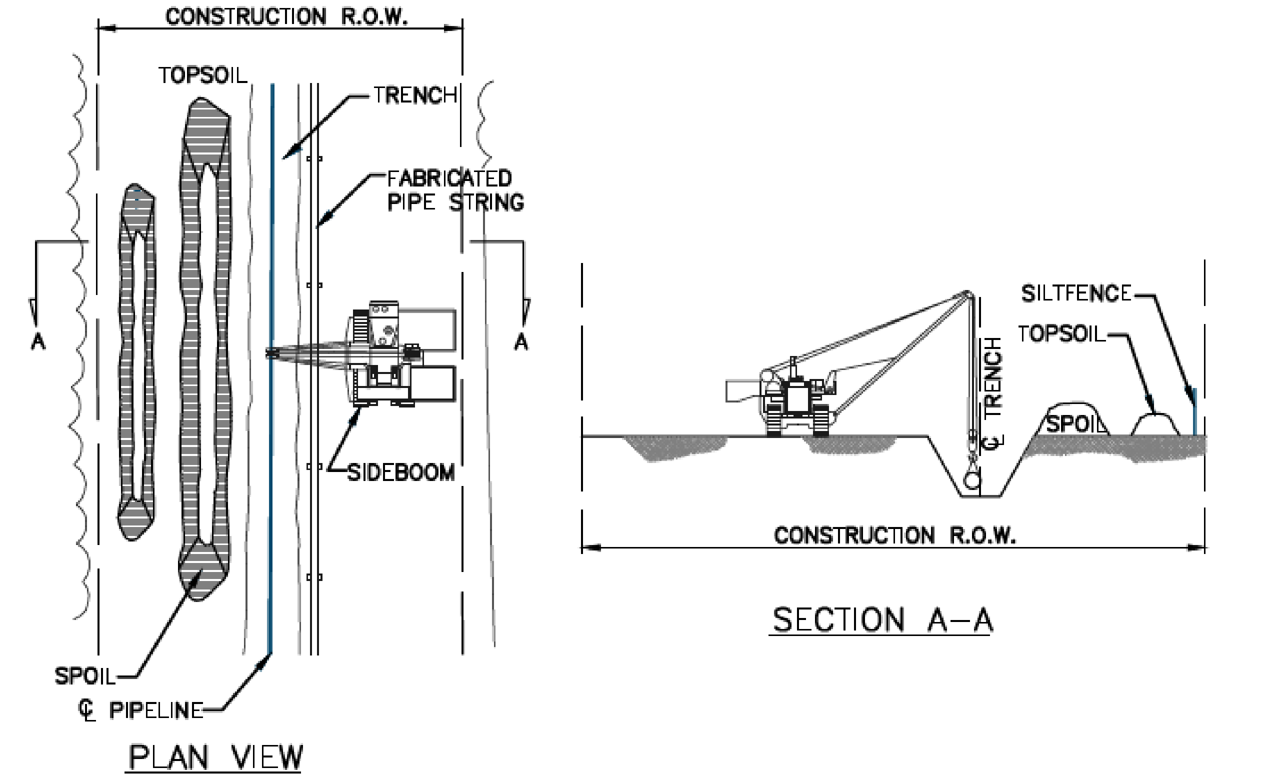
CONSTRUCTION PROCEDURES:

1. FLAG WETLAND BOUNDARIES PRIOR TO CLEARING.
2. NO REFUELING OF MOBILE EQUIPMENT IS ALLOWED WITHIN 100 FEET OF WETLAND. PLACE "NO FUELING" SIGN POST APPROXIMATELY 100 FEET FROM WETLAND BOUNDARY. REFUEL STATIONARY EQUIPMENT AS PER THE PROJECTS SPILL PREVENTION PROCEDURES.
3. INSTALL TEMPORARY SLOPE BREAKER UPSLOPE WITHIN 100 FEET OF WETLAND BOUNDARY IF DIRECTED BY THE PROJECT.
4. INSTALL TIMBER MATS THROUGH ENTIRE WETLAND AREA. EQUIPMENT NECESSARY FOR RIGHT–OF WAY– CLEARING MAY MAKE ONE (1) PASS THROUGH THE WETLAND BEFORE MATS ARE INSTALLED. GEOTEXTILE FABRIC MAY BE INSTALLED UNDER TIMBER MATS, WHERE REQUIRED.
5. AVOID ADJACENT WETLANDS. INSTALL SEDIMENT BARRIERS (STRAW BALES AND/OR SILT FENCE) AT DOWN SLOPE EDGE OF RIGHT–OF–WAY AND ALONG EDGE AS REQUIRED. A SEDIMENT FILTER DEVICE WILL BE PLACED ACROSS THE WORKSPACE AT THE WETLAND EDGE, IMMEDIATELY UPSLOPE OF THE WETLAND BOUNDARY AS WELL.
6. RESTRICT ROOT GRUBBING TO ONLY THAT AREA OVER THE DITCHLINE AND DITCH SPOIL AREAS AND REMOVE FROM WETLAND FOR DISPOSAL.
7. TOPSOIL STRIPPING SHALL NOT BE REQUIRED IN SATURATED SOIL CONDITIONS.
8. LEAVE HARD PLUGS AT EDGE OF WETLAND UNTIL JUST PRIOR TO TRENCHING.
9. ASSEMBLE THE PIPELINE IN AN UPLAND AREA UNLESS THE WETLAND IS DRY ENOUGH TO ADEQUATELY SUPPORT SKIDS AND PIPE.
10. TRENCH THROUGH WETLANDS. DO NOT TRENCH THE WETLAND UNTIL THE PIPELINE IS ASSEMBLED AND READY FOR LOWERING IN.
11. LOWER–IN PIPE, INSTALL TRENCH PLUGS AT WETLAND EDGES AS REQUIRED AND BACKFILL IMMEDIATELY.
12. REMOVE TIMBER MATS OR PRE–FABRICATED MATS FROM WETLAND UPON COMPLETION AND ACCESS IS NO LONGER NEEDED.
13. RESTORE GRADE TO NEAR PRE–CONSTRUCTION TOPOGRAPHY, REPLACE TOPSOIL IF SALVAGED AND INSTALL PERMANENT EROSION CONTROL.

NOT TO SCALE

TC Energy	STANDARD WETLAND CROSSING METHOD	FIGURE NO. 18

Figure 19 – “Dry” Wetland Crossing Method



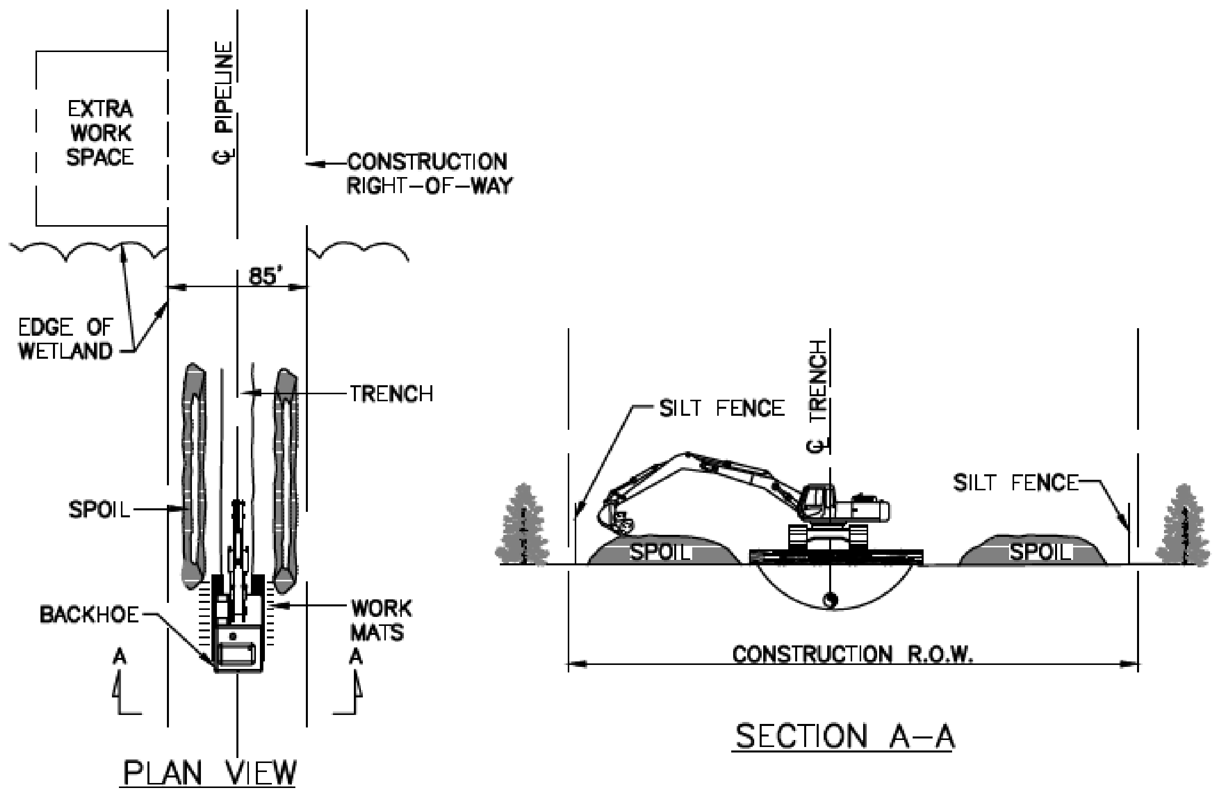
CONSTRUCTION PROCEDURES:

1. THIS METHOD APPLIES TO WETLAND BEING CULTIVATED AND BEING FARMED, OR FIRM ENOUGH TO SUPPORT EQUIPMENT WITHOUT RUTTING AT THE TIME OF CROSSING. NO WETLAND CONSTRUCTION PROCEDURES ARE REQUIRED.
2. FLAG WETLAND BOUNDARIES PRIOR TO CLEARING.
3. NO REFUELING OF MOBILE EQUIPMENT IS ALLOWED WITHIN 100 FEET OF WETLAND. REFUEL STATIONARY EQUIPMENT AS PER THE PROJECT'S SPILL PREVENTION PROCEDURES.
4. INSTALL SLOPE BREAKER UPSLOPE WITHIN 50 FEET OF WETLAND BOUNDARY IF DIRECTED BY THE PROJECT.
5. CONSTRUCT WHEN DRY, IF POSSIBLE. IF SITE BECOMES WET AT TIME OF TRENCHING, AVOID SOIL COMPACTION BY UTILIZING TIMBER RIP–RAP OR PREFABRICATED EQUIPMENT MATS. GEOTEXTILE FABRIC MAY BE INSTALLED UNDER TIMBER MATS, WHERE REQUIRED.
6. AVOID ADJACENT WETLANDS. INSTALL SEDIMENT BARRIERS AT DOWN SLOPE EDGE OF RIGHT–OF–WAY ALONG WETLAND EDGE IF EVIDENT, OTHERWISE INSTALL BARRIER ON BOTH EDGES AS REQUIRED. A SEDIMENT FILTER DEVICE WILL BE PLACED ACROSS THE WORKSPACE AT THE WETLAND'S EDGE, IMMEDIATELY UPSLOPE OF THE WETLAND BOUNDARY.
7. RESTRICT ROOT GRUBBING TO ONLY THAT AREA OVER THE DITCHLINE AND REMOVE STUMPS FROM WETLAND FOR DISPOSAL.
8. CONDUCT TRENCH LINE TOPSOIL STRIPPING (IF TOPSOIL IS NOT SATURATED). SALVAGE TOPSOIL TO ACTUAL DEPTH OR A MAXIMUM DEPTH OF 12 INCHES.
9. TRENCH THROUGH WETLANDS.
10. PIPE SECTION TO BE FABRICATED WITHIN THE WETLAND AND ADJACENT TO ALIGNMENT, OR IN STAGING AREA OUTSIDE THE WETLAND AND WALKED IN.
11. LOWER–IN PIPE PRIOR TO BACKFILLING TRENCH, IF REQUIRED, TRENCH PLUGS SHALL BE INSTALLED AS REQUIRED. BACKFILL TRENCH.
12. RESTORE GRADE TO NEAR PRE–CONSTRUCTION TOPOGRAPHY, REPLACE TOPSOIL AND INSTALL PERMANENT EROSION CONTROL.
13. IF UTILIZED, REMOVE TIMBER MATS OR PRE–FABRICATED MATS FROM WETLAND UPON COMPLETION WHEN NO LONGER NEEDED FOR ACCESS.

NOT TO SCALE

TC Energy	"DRY" WETLAND CROSSING METHOD	FIGURE NO. 19

Figure 20 – Push/Pull Wetland Crossing Method



CONSTRUCTION PROCEDURES:

1. FLAG WETLAND BOUNDARIES PRIOR TO CLEARING.
2. NO REFUELING OF MOBILE EQUIPMENT IS ALLOWED WITHIN 100 FEET OF WETLAND. PLACE "NO FUELING" SIGN POST APPROXIMATELY 100 FEET FROM WETLAND BOUNDARY. REFUEL STATIONARY EQUIPMENT AS PER THE PROJECTS SPILL PREVENTION PROCEDURES.
3. INSTALL TEMPORARY SLOPE BREAKER UPSLOPE WITHIN 100 FEET OF WETLAND BOUNDARY IF DIRECTED BY THE PROJECT.
4. RESTRICT ROOT GRUBBING TO ONLY THE AREA OVER THE DITCHLINE.
5. TOPSOIL STRIPPING SHALL NOT BE REQUIRED IN SATURATED SOIL CONDITIONS.
6. IF FABRICATED TIMBER MATS ARE USE FOR STABILIZATION, THE BACKHOE SHALL GRADUALLY MOVE ACROSS THE WETLAND BY MOVING THE MAT FROM IMMEDIATELY BEHIND TO IMMEDIATELY IN FRONT OF THE THE BACKHOES PATH. GEOTEXTILE FABRIC MAY BE INSTALLED UNDER MATS, WHERE REQUIRED.
7. AVOID ADJACENT WETLANDS. INSTALL SEDIMENT BARRIERS (STRAW BALES AND/OR SILT FENCE) AT DOWN SLOPE EDGE OF RIGHT–OF–WAY ALONG EDGE IF EVIDENT, OTHERWISE INSTALL BARRIER ON BOTH EDGES AS REQUIRED.
8. FABRICATE PIPE IN STAGING AREA OUTSIDE OF THE WETLAND IN THE EXTRA WORK SPACE AS INDICATED ON THE CONSTRUCTION DRAWINGS.
9. LEAVE HARD PLUGS AT EDGE OF WETLAND UNTIL JUST PRIOR TO TRENCHING.
10. FLOAT PIPE IN PLACE, LOWER–IN, INSTALL TRENCH PLUGS AT WETLAND EDGES WHERE REQUIRED AND BACKFILL IMMEDIATELY.
11. REMOVE TIMBER MATS OR PRE–FABRICATED MATES FROM WETLAND EDGES AS REQUIRED AND BACKFILL IMMEDIATELY.
12. RESTORE GRADE TO NEAR PRE–CONSTRUCTION TOPOGRAPHY, REPLACE TOPSOIL IF SALVAGED AND INSTALL PERMANENT EROSION CONTROL.
13. THE CONSTRUCTION RIGHT–OF–WAY FOR THIS TYPE OF CONSTRUCTION SHALL BE 85 FEET.

NOT TO SCALE

TC Energy	PUSH/PULL WETLAND CROSSING METHOD	FIGURE NO. 20

Figure 21 – Typical Open Cut Wet Crossing Method Non-Flowing Waterbody – REMOVED

This figure has been removed in response to a comment letter from the VADEQ dated September 30, 2020.

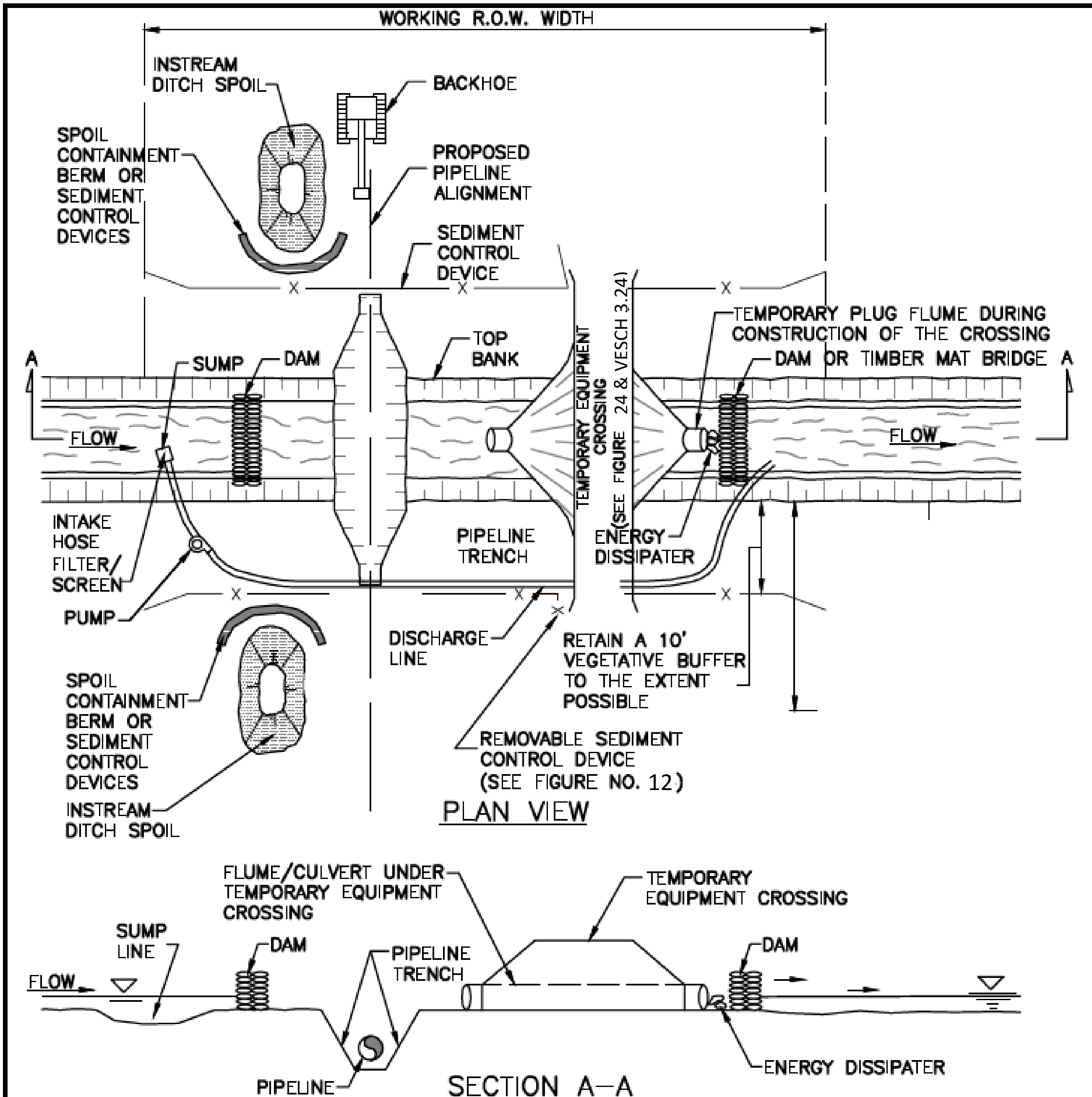
Figure 22 – Typical Open Cut Wet Crossing Method Flowing Waterbody – REMOVED

This figure has been removed in response to a comment letter from the VADEQ dated September 30, 2020.

Figure 22A – Typical Flowing Waterbody Crossing Method Construction Procedures – REMOVED

This figure has been removed in response to a comment letter from the VADEQ dated September 30, 2020.

Figure 23 – Typical Dam and Pump Crossing



NOTES:

1. PIPELINE PLACEMENT WITHIN RIGHT–OF–WAY CONCEPTUAL ONLY.
2. SEE FIGURE 23A FOR CONSTRUCTION PROCEDURES.

NOT TO SCALE

TC Energy	TYPICAL DAM AND PUMP CROSSING	FIGURE NO. 23

Figure 23A – Typical Dam and Pump Crossing

CONSTRUCTION PROCEDURES:

1. IF THERE IS ANY FLOW IN THE WATERCOURSE, INSTALL PUMPS TO MAINTAIN STREAMFLOW AROUND THE BLOCK OFF SECTIONS OF CHANNEL. A SECOND STANDBY PUMP OF EQUAL CAPACITY IS TO BE READILY AVAILABLE AT ALL TIMES. PUMP INTAKES WILL BE SCREENED TO MINIMIZE FISH ENTRAINMENT. AN ENERGY DISSIPATER IS TO BE BUILT TO ACCEPT PUMP DISCHARGE WITHOUT STREAMBED OR STREAMBANK EROSION. IF THE CROSSING IS PROLONGED BEYOND ONE DAY THE OPERATION NEED TO BE MONITORED OVERNIGHT.

2. SCHEDULE INSTREAM ACTIVITY FOR LOW FLOW PERIODS IF POSSIBLE.

3. MARK OUT AND MAINTAIN LIMITS OF AUTHORIZED WORK AREAS WITH FENCING OR FLAGGING TAPE TO AVOID UNNECESSARY DISTURBANCE OF VEGETATION. ENSURE EQUIPMENT OPERATORS WORKING ON THE CROSSING HAVE BEEN BRIEFED ABOUT THIS PLAN AND THE MEASURE NEEDED TO PROTECT WATER QUALITY. INSTALL PRE-WORK SEDIMENT CONTROL MEASURES AS SPECIFIED IN THE PLAN OR IN ACCORDANCE WITH THE ECS. ALL NECESSARY EQUIPMENT AND MATERIALS TO BUILD THE DAMS AND TO PUMP WATER MUST BE ON SITE OR READILY AVAILABLE PRIOR TO COMMENCING IN-WATER CONSTRUCTION. PIPE SHOULD BE READY FOR INSTALLATION PRIOR TO WATERCOURSE TRENCHING.

4. INSTALL AND MAINTAIN SEDIMENT CONTROL STRUCTURES, AS DEPICTED AND ALONG DOWN GRADIENT SIDES OF WORK AREAS AND STAGING AREAS SUCH THAT NO SILT LADEN WATER ENTERS STREAM.

   a. NO SILT LADEN WATERS SHALL BE DISCHARGED DIRECTLY INTO THE STREAM.

   b. EROSION AND SEDIMENT CONTROL STRUCTURE LOCATIONS AS DEPICTED ARE APPROXIMATE AND MAY BE ADJUSTED AS DIRECTED BY THE COMPANY INSPECTOR TO ACTUAL SITE CONDITIONS.

   c. SEDIMENT CONTROL DEVICE INSTALLATION SHALL INCLUDE REMOVABLE SECTIONS TO FACILITATE ACCESS DURING CONSTRUCTION. UTILIZE REMOVABLE SEDIMENT CONTROL DEVICE ONLY IN LIEU OF A SILT FENCE WHERE FREQUENT ACCESS IS REQUIRED.

   d. SEDIMENT LADEN WATER FROM TRENCH DEWATERING SHALL BE DISCHARGED TO A WELL VEGETATED UPLAND AREA INTO A STRAW BALE DEWATERING STRUCTURE OR GEOTEXTILE FILTER BAG.

   e. SEDIMENT CONTROL STRUCTURES MUST BE IN PLACE AT ALL TIMES ACROSS THE DISTURBED PORTIONS OF THE RIGHT-OF-WAY EXCEPT DURING EXCAVATION/INSTALLATION OF THE CROSSING PIPE.

   f. SOFT DITCH PLUGS MUST REMAIN IN PLACE AT CONVENIENT LOCATIONS TO SEPARATE MAINLINE DITCH FROM THE RIVER CROSSING UNTIL THE RIVER CROSSING IS INSTALLED AND BACKFILLED.

5. TO THE EXTENT POSSIBLE, MAINTAIN A MINIMUM 10 FT VEGETATIVE BUFFER STRIP BETWEEN DISTURBED AREAS AND THE WATERCOURSE. INSTALL AND MAINTAIN A SEDIMENT CONTROL DEVICE UPSLOPE OF THE BUFFER STRIP ON EACH SIDE OF THE WATERCOURSE.

6. EXCAVATED MATERIAL MUST NOT BE STOCKPILED WITHIN 10 FT. OF THE WATERCOURSE. THIS MATERIAL MUST BE CONTAINED WITHIN BERM CONTAINMENT OR SEDIMENT CONTROL DEVICE WITH SECONDARY SILT FENCE PROTECTION TO PREVENT SATURATED SOIL FROM FLOWING BACK INTO THE WATERCOURSE.

7. CHEMICALS, FUELS, LUBRICATING OILS, SHALL NOT BE STORED AND EQUIPMENT REFILLED WITHIN 100 FT. OF THE WATERBODY. PUMPS ARE TO BE REFUELED AS PER THE SPCC PLANS.

8. STAGING AREAS ARE TO BE LOCATED AT LEAST 10 FT. FROM THE WATERS EDGE (WHERE TOPOGRAPHIC CONDITIONS PERMIT) AND SHALL BE THE MINIMUM SIZE NEEDED.

9. DAMS ARE TO BE MADE OF STEEL PLATE, INFLATABLE PLASTIC DAM OR SAND BAGS. DAMS MAY NEED KEYING INTO THE BANKS AND STREAMBED. ENSURE THAT THE DAM AND VEHICLE CROSSINGS ARE LOCATED FAR ENOUGH APART TO ALLOW FOR A WIDE EXCAVATION.

10. EXCAVATE TRENCH THROUGH PLUGS AND STREAMBED FROM BOTH SIDES, RE-POSITIONING DISCHARGE HOSE AS NECESSARY. LOWER THE PIPE IN THE TRENCH AND BACKFILL IMMEDIATELY. DURING THIS OPERATION WORK IS TO BE COMPLETED AS QUICKLY AS POSSIBLE.

11. RESTORE THE STREAM BED AND BANKS TO APPROXIMATE PE-CONSTRUCTION CONTOURS OR A STABLE ANGLE OF REPOSE, AS APPROVED BY THE ENVIRONMENTAL INSPECTOR.

   a. INSTALL PERMANENT EROSION AND SEDIMENT CONTROL STRUCTURES AS INDICATED ONSITE SPECIFIC BASIS. ALTERNATIVELY, ROCK RIP-RAP SHALL BE INSTALLED.

   b. ANY MATERIALS PLACE IN THE STREAM TO FACILITATE CONSTRUCTION SHALL BE REMOVED DURING RESTORATION. BANKS SHALL BE STABILIZED AND TEMPORARY SEDIMENT BARRIERS INSTALLED AS SOON AS POSSIBLE AFTER CROSSING, BUT WITHIN 24 HOURS OF COMPLETING THE CROSSING.

   c. MAINTAIN SEDIMENT CONTROL DEVICE ALONG THE WATER COURSE UNTIL VEGETATION IS ESTABLISHED IN ADJACENT DISTURBED AREAS.

15. WHEN THE STREAMBED HAS BEEN RESTORED, THE CREEK BANKS ARE TO BE CONTOURED TO A STABLE ANGLE AND PROTECTED WITH EROSION RESISTANCE MATERIAL COMPATIBLE WITH FLOW VELOCITY BETWEEN DAMS (E.G., EROSION CONTROL BLANKETS, CRIBBING, ROCK RIP-RAP, ETC.) THE DAMS ARE TO BE REMOVED DOWNSTREAM FIRST. KEEP PUMP RUNNING UNTIL NORMAL FLOW IS RESUMED. COMPLETE BANK TRIMMING AND EROSION PROTECTION. IF SANDBAGS ARE USED FOR THE DAMS, PLACE AND REMOVE BY HAND TO AVOID EQUIPMENT BREAKING BAGS.

TC Energy	TYPICAL DAM AND PUMP CROSSING	FIGURE NO. 23A

Figure 24 – Typical Railcar Bridge Crossing

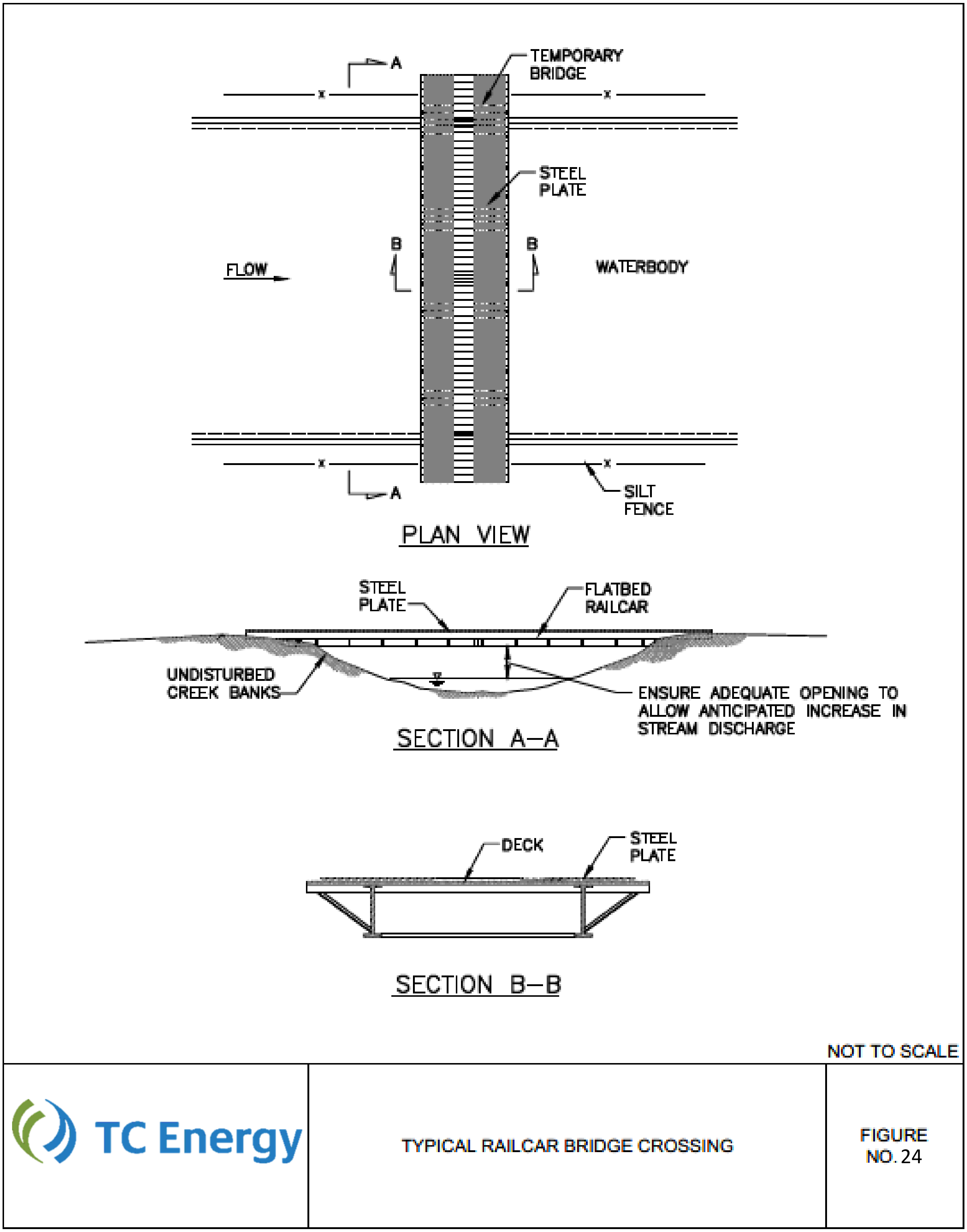


Figure 24A – Typical Railcar Bridge Crossing

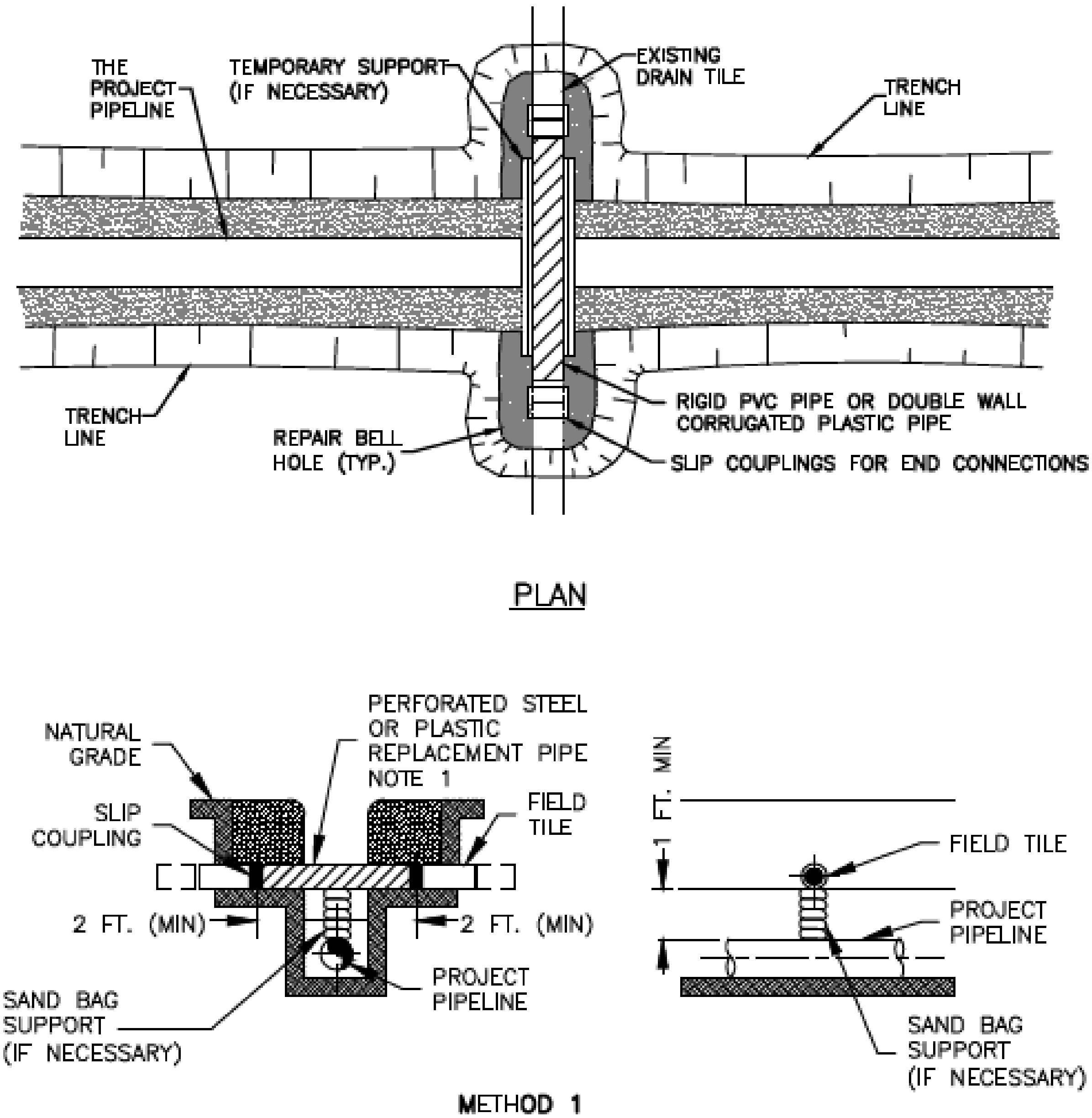
CONSTRUCTION PROCEDURES:

1. THIS TYPICAL DRAWING PROVIDES FOR A RAILCAR BRIDGE EQUIPMENT CROSSING.
2. BRIDGE SHOULD BE A MINIMUM OF 12 FEET LONGER THAN BANK TO BANK WIDTH.
3. BEST MANAGEMENT PRACTICES UTILIZING SEDIMENT CONTROL DEVICES ARE REQUIRED TO PREVENT SEDIMENTATION OF THE STREAM. EROSION PROTECTION SHALL BE PLACED ON THE STREAM BANKS.
4. DURING FINAL CLEAN-UP, REMOVE TEMPORARY EQUIPMENT CROSSINGS AS SOON AS POSSIBLE. INSTALLED MATERIALS, SUCH AS SEDIMENT CONTROL DEVICES MUST BE REMOVED AND DISPOSED IN ACCORDANCE WITH STATE AND LOCAL REGULATIONS AND REQUIREMENTS. THE STREAMBED, BANKS, AND AREAS AFFECTED BY CONSTRUCTION OF THE TEMPORARY EQUIPMENT CROSSING SHOULD BE RESTORED TO A STABLE CONDITION. IF REQUIRED TO PREVENT TRANSPORT OF SEDIMENTATION TO THE STREAM, SEDIMENT CONTROL DEVICE SHOULD BE INSTALLED AT THE TOP OF THE BANKS.

NOT TO SCALE

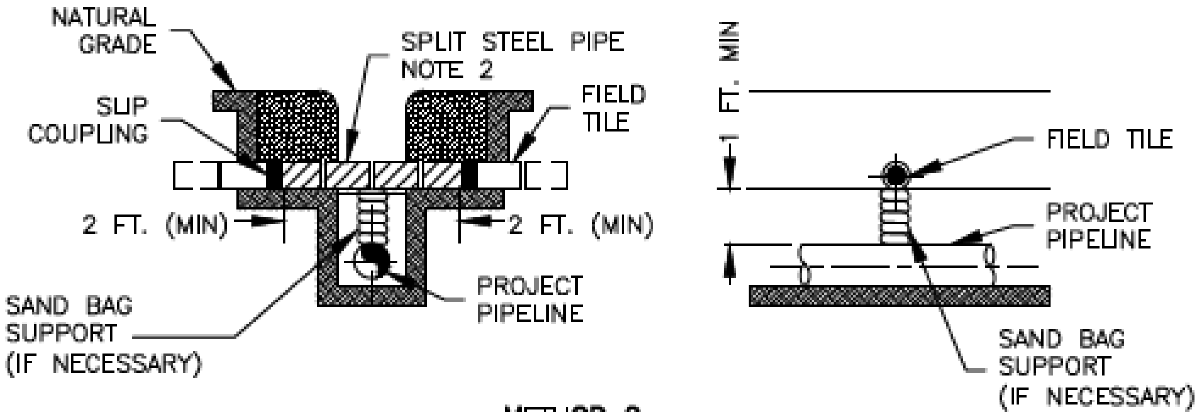
TC Energy	TYPICAL RAILCAR BRIDGE CROSSING	FIGURE NO. 24A

Figure 25 – Field Tile Replacement Methods

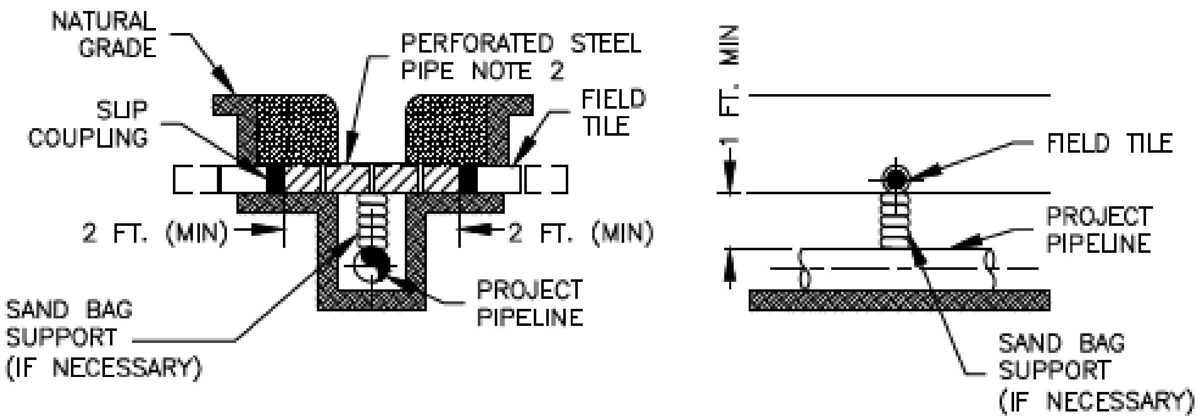


TC Energy	FIELD TILE REPLACEMENT METHODS	FIGURE NO. 25

Figure 25A – Field Tile Replacement Methods



METHOD 2



METHOD 3

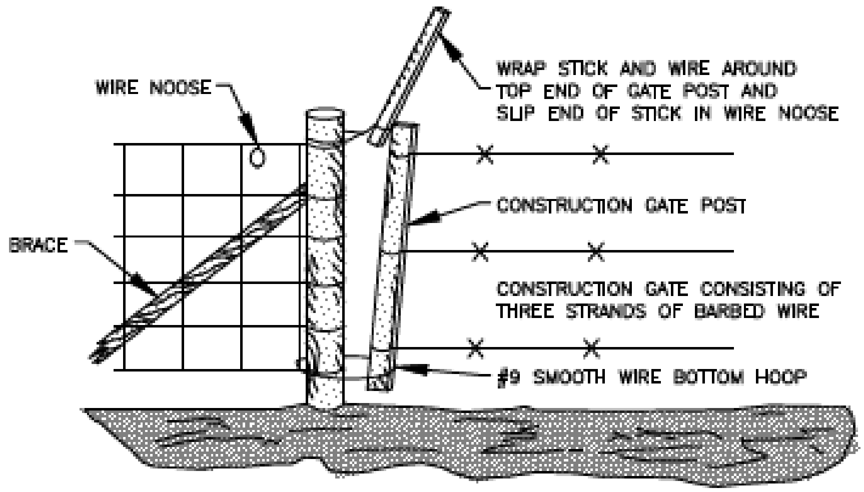
NOTES:

1. REPLACEMENT PIPE TO BE AS NEAR AS POSSIBLE TO DIAMETER OF THE FIELD TILE.
2. STEEL CARRIER PIPE TO HAVE INSIDE DIAMETER AS NEAR AS POSSIBLE THE OUTSIDE DIAMETER OF THE FIELD TILE.
3. MAINTAIN ORIGINAL FLOW LINE OF FIELD TILE IN ALL METHODS.

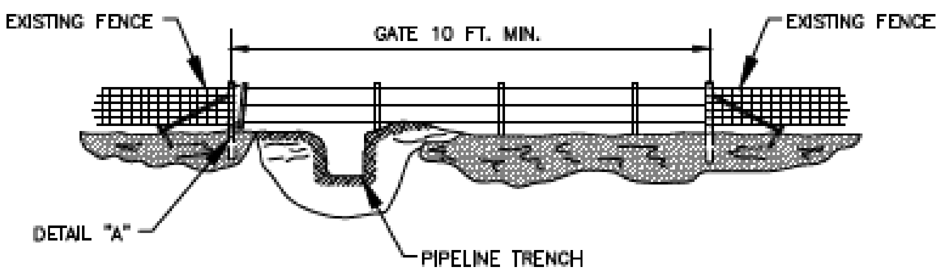
NOT TO SCALE

TC Energy	FIELD TILE REPLACEMENT METHODS	FIGURE NO. 25A

Figure 26 – Temporary Construction Gate Right-of-Way



DETAIL "A"



NOTES:

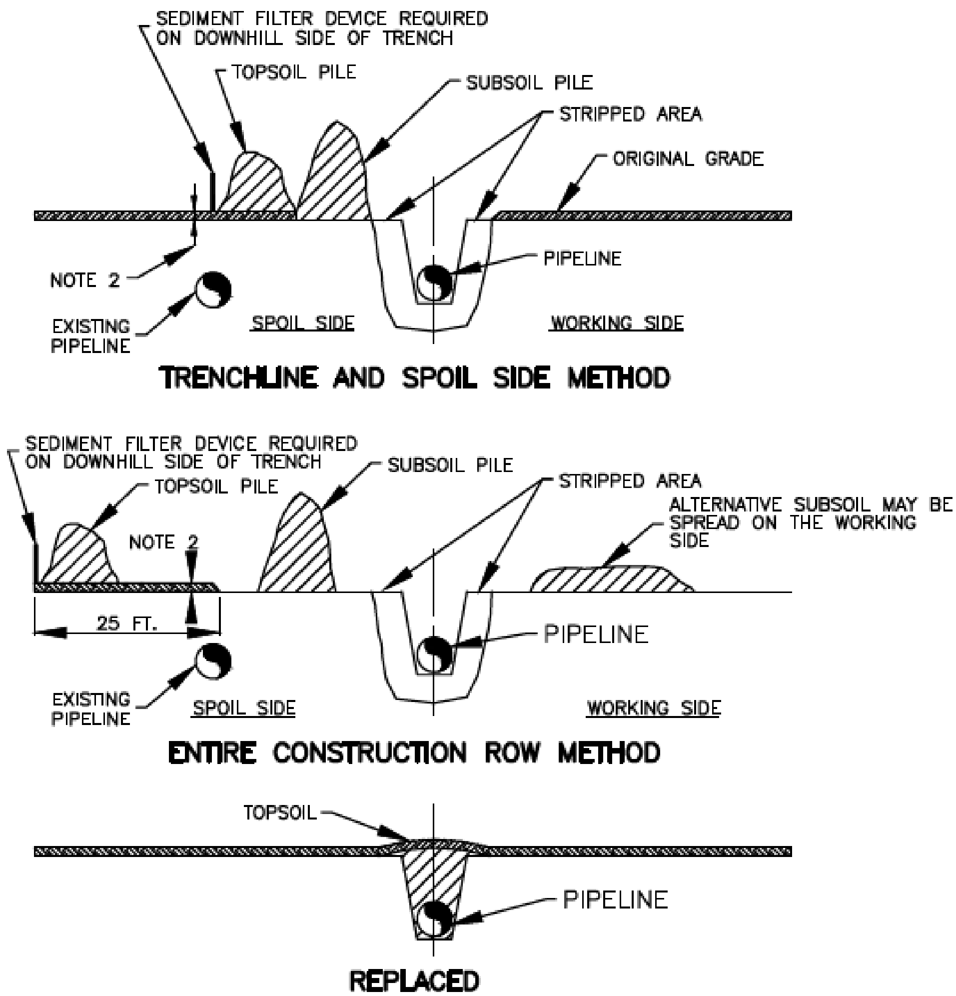
1. IF EXISTING FENCE POSTS ARE STEEL "T" BAR TYPE, THEN REMOVE THE STEEL "T" BAR POST ON BOTH SIDES OF THE GATE OPENING AND REPLACE WITH TEMPORARY WOODEN POSTS, BRACED AS SHOWN.

2. SUITABLE SUBSTITUTES FOR STICK AND WIRE GATE FASTENER ARE PERMISSIBLE.

NOT TO SCALE

TC Energy	TEMPORARY CONSTRUCTION GATE RIGHT-OF-WAY	FIGURE NO. 26

Figure 27 – Typical Topsoil Conservation



NOTES:

1. OTHER CONFIGURATIONS OF TOPSOIL AND SUBSOIL ARE ACCEPTABLE PROVIDED THEY ARE KEPT SEPARATE.
2. UP TO 12 INCHES OF TOPSOIL REMOVED.
3. TOPSOIL AND SUBSOIL PILES WILL BE ADEQUATELY PROTECTED FROM EROSION AND SEDIMENTATION BY USE OF SEDIMENT FILTER DEVICE OR MULCH.

NOT TO SCALE

TC Energy	TYPICAL TOPSOIL CONSERVATION	FIGURE NO. 27

Addendum to Erosion and Sediment Control and Stormwater Annual Standards and Specifications

1. These Annual Standards and Specifications are composed of specifications for erosion and sediment control and stormwater management that apply to regulated land-disturbing activities and include by reference the following:

Virginia Erosion and Sediment Control Law (§62.1-44.15:51 et seq. as amended);
Virginia Erosion and Sediment Control Regulations (9VAC25-840 et seq. as amended);
Virginia Erosion and Sediment Control Certification Regulations (9VAC25-850 et seq. as amended);
Virginia Stormwater Management Act (§62.1-44.15:24 et seq. as amended);
Virginia Stormwater Management Program Regulations (9VAC25-870 et seq. as amended);
General VPDES Permit for Discharges of Stormwater from Construction Activities (9VAC25-880 et seq. as amended);

2. When stormwater management control devices or other techniques are required for regulated land-disturbing activities their individual project specific plans (construction drawings/sheets and narrative) will contain adequate information to ensure the long-term responsibility and maintenance of the required stormwater management control devices or other techniques.

3. Erosion and Sediment Control and Stormwater Management Program administration, plan design, review and approval and construction inspection and enforcement will be conducted in compliance with the approved Annual Standards and Specifications and all referenced laws, regulations, handbooks, and technical bulletins.

4. A Virginia Department of Environmental Quality (VADEQ) Certified Responsible Land Disturber will be named for each regulated land-disturbing activity prior to initiating land-disturbance. Erosion and Sediment Control and Stormwater Management Program personnel will have already obtained certification or will enroll in the VADEQ Erosion and Sediment Control and Stormwater Management Training and Certification Program to obtain certifications comparable to those required for local government or Erosion and Sediment Control and Stormwater Management Program personnel.

5. The following information will be submitted to the VADEQ in the e-notification two weeks prior to initiating a regulated land disturbing activity:

- project name or project number;
- project location (including nearest major intersection, latitude and longitude);
- on-site project manager name and contact information;
- Environmental Inspector (EI) name and contact info;
- Responsible Land Disturber (RLD) name and contact info;
- project description;
- acreage of disturbed area for project;
- project access point;
- project start and finish dates; and

- any variances/exemptions/waivers associated with the project.

An electronic copy of this notification will be available for project tracking purposes.

6. For large projects, or by request of the VADEQ, project-specific plans will be posted for public review and approval; the operator, if under the VAR10 GP, will post the notice of coverage letter at a publicly accessible location near an active part of the construction project (e.g., where a pipeline crosses a public road), and maintain the posting until coverage under the general permit is terminated; and the following information will be submitted as part of the weekly e-reporting to the regional VADEQ office:

- Inspection reports;
- Pictures;
- Complaint logs and complaint responses; and
- Other compliance documents.

The VADEQ will determine which construction projects are considered ‘large’ projects on a case-by-case basis; at a minimum, projects that encompass 50 miles of pipeline should be planned to be considered as large projects.

7. In compliance with §62.1-44.15:55 of the Virginia Erosion and Sediment Control Law, on-site changes to the individual project specific plan may occur when adequate documentation of the changes are shown on the individual project specific plan and the Stormwater Management Pollution Prevention Plan (if required).

Attachment A

Virginia Erosion and Sediment Control Handbook (VESCH) Specifications

Table of Contents

Note: Page numbers are not consecutive as some VESCH Chapter 3 Specifications were not included in Attachment A.

STD & SPEC 3.01

SAFETY FENCE

SAF

Definition

A protective barrier installed to prevent access to an erosion control measure.

Purpose

To prohibit the undesirable use of an erosion control measure by the public.

Conditions Where Practice Applies

Applicable to any control measure or series of measures which can be considered unsafe by virtue of potential for access by the public.

Planning Considerations

The safety of the public must always be considered at both the planning and implementation phases of a land-disturbing activity. If there is any question concerning the risk of a particular erosion control measure to the general public, the measure should be relocated to a safer area, or an appropriate safety fence should be installed to prevent undesired access. Many times, the danger posed by a control may not be easily seen by plan designers and reviewers - that is when the on-site contractor or inspector must correct such situations in the field. Properly designed and installed safety fences prevent the trespassing of people into potentially dangerous areas, such as children using a sediment basin or a stormwater retention structure as play areas. The installation of these fences will protect people from hazards and the owner from possible litigation.

Two different types of fence will be discussed in this specification. The designer, developer, and contractor should always be sure that the most appropriate type of fence is utilized for a particular need.

Design Criteria

1. Safety fences should be located so as to create a formidable barrier to undesired access, while allowing for the continuation of necessary construction operations.

2. Safety fences are most applicable to the construction of berms, traps, and dams. In use with those structures, safety fences should be located far enough beyond the outer toe of the embankment to allow for the passage of maintenance vehicles. Fences should not be installed across the slope of a dam or dike.

3. The height of the fence shall be a minimum of 5 feet for plastic fence and 6 feet for metal fence. A fence must never be so short as to become an attraction for children to climb on or over.

4. Signs noting potential hazards such as "DANGER-QUICKSAND" or "HAZARDOUS AREA - KEEP OUT" should be posted and easily seen by anyone approaching the protected area.

5. Plastic (polyethylene) fence may be used as safety fencing, primarily in situations where the need is for a temporary barrier (see Plate 3.01-1). The fence should meet the physical requirements noted in the following table:

TABLE 3.01-A

PHYSICAL PROPERTIES OF PLASTIC SAFETY FENCE

Physical Property	Test	Requirements
Recommended color	N/A	"International" orange
Tensile yield	ASTM D638	Average 2000 lbs. per 4 ft. width
Ultimate tensile strength	ASTM D638	Average 2900 lbs. per 4 ft. width
Elongation at break(%)	ASTM D638	Greater than 1000%
Chemical resistance	N/A	Inert to most chemicals and acids

Source: Conwed Plastics

6. Metal or "chain-link" fence should be used when a potentially dangerous control measure will remain in place permanently, such as a stormwater detention or retention basin (see Plate 3.01-1). However, they may also be used for measures which will only serve a temporary function, at the discretion of those responsible for project safety. The metal fence must meet the following physical requirements:

   a. Fabric shall be zinc-coated steel, 2-inch mesh, 9-gauge, minimum.

   b. Zinc coating shall have a minimum weight of 1.8 ounces per square foot.

   c. Posts shall be steel pipe, zinc-coated.

   d. Top nails shall be steel pipe, zinc-coated.

   e. Braces shall be made of zinc-coated steel.

   f. Gates shall be single or double swing, zinc-coated steel. They shall be a minimum of 12-feet wide.

Construction Specifications

1. Safety fences must be installed prior to the E&S measure becoming accessible.

2. The polyethylene web of the plastic safety fence shall be secured to a conventional metal "T" or "U" post driven into the ground to a minimum depth of 18 inches; posts should be spaced at 6-foot centers. See "perspective" view in Plate 3.01-1.

3. The metal safety fence shall be installed as per the following procedure:

    a. Line posts shall be placed at intervals of 10 feet measured from center to center of adjacent posts. In determining the post spacing, measurement will be made parallel with the ground surface. See "perspective" view in Plate 3.01-1.

    b. Posts will be set in concrete and backfilled or anchored by other acceptable means.

    c. Posts set in the tops of concrete walls shall be grouted into preformed holes to a minimum depth of 12 inches.

    d. All corner posts, end posts, gate posts, and pull posts shall be embedded, braced, and trussed as shown in the "Standard Fence - Chain Link" detail found in the latest version of the Virginia Department of Transportation (VDOT) Road and Bridge Standards.

    e. Fencing fabric shall not be stretched until at least 4 days after the posts are grouted into walls or 14 days after the posts are set into concrete.

    f. The fabric shall be stretched taut and securely fastened, by means of tie clips, to the posts at intervals not exceeding 15 inches and to the top rails or tension wires at intervals not exceeding 2 feet. Care shall be taken to equalize the tension on each side of each post.

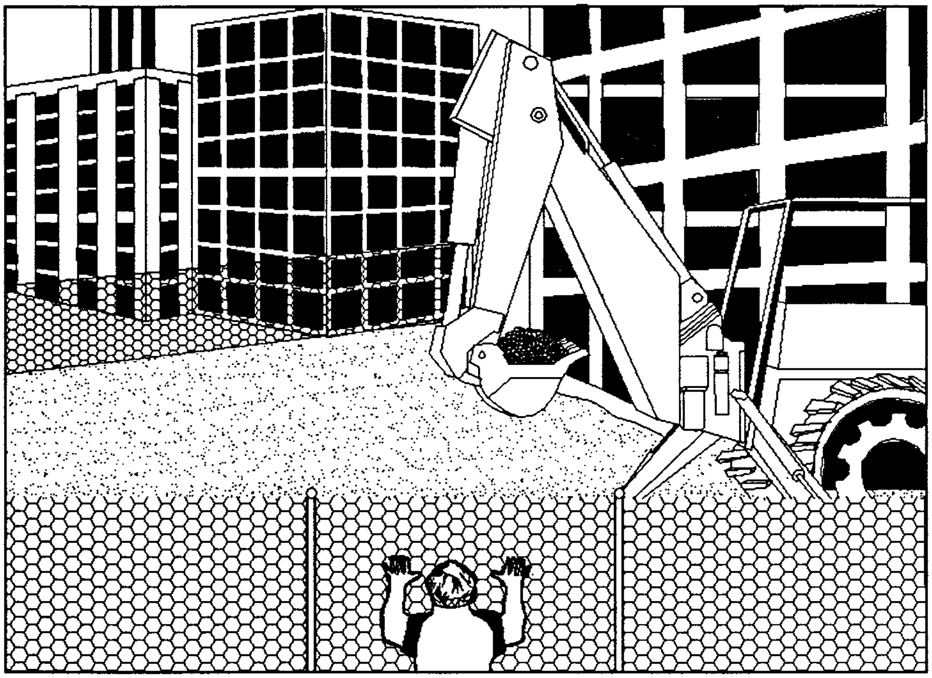
4. Applicable warning signs noting hazardous conditions must be installed immediately upon installation of safety fence.

Maintenance

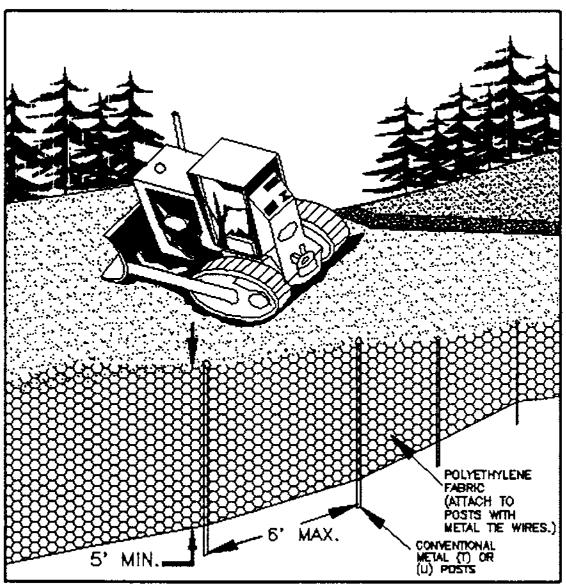
1. Safety fence shall be checked regularly for weather-related or other damage. Any necessary repairs must be made immediately.

2. Care should be taken to secure all access points (gates) at the end of each working day. All locking devices must be repaired or replaced as necessary.

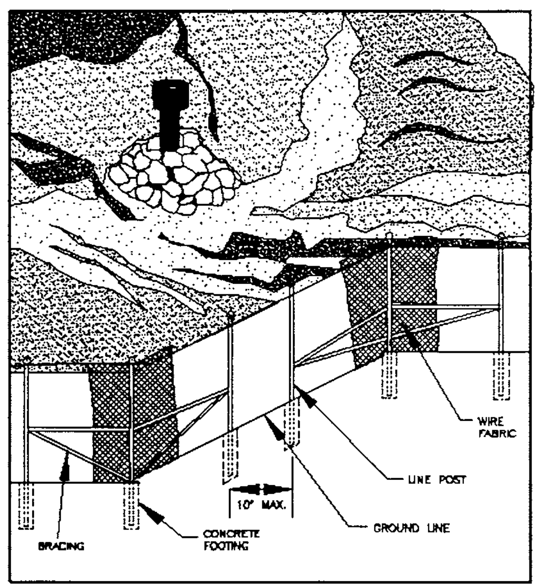
SAFETY FENCE



PERSPECTIVE VIEW



PERSPECTIVE VIEW
PLASTIC FENCE

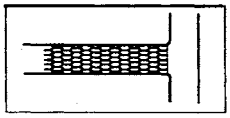


PERSPECTIVE VIEW
METAL FENCE

Source: Adapted from Conwed Plastics and VDOT <u>Road and Bridge Standards</u>

Plate 3.01-1

STD & SPEC 3.02



TEMPORARY STONE CONSTRUCTION ENTRANCE

CE

Definition

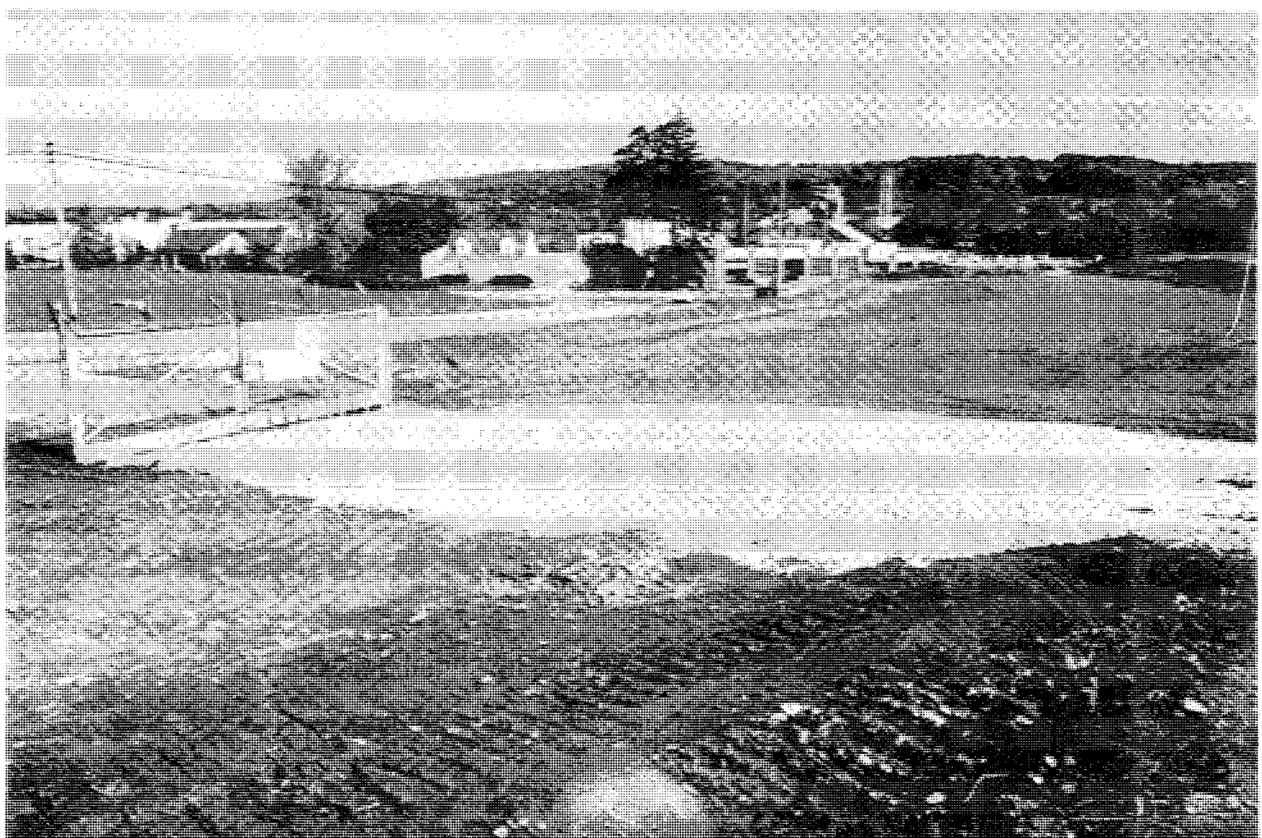
A stabilized stone pad with a filter fabric underliner located at points of vehicular ingress and egress on a construction site.

Purpose

To reduce the amount of mud transported onto paved public roads by motor vehicles or runoff.

Conditions Where Practice Applies

Wherever traffic will be leaving a construction site and move directly onto a public road or other paved area.



Planning Considerations

Minimum Standard #17 (MS #17) requires that provisions be made to minimize the transport of sediment by vehicular traffic onto a paved surface. Construction entrances provide an area where a significant amount of mud can be removed from construction vehicle tires before they enter a public road and, just as important, the soil adjacent to the paved surface can be kept intact. A filter fabric liner is used as a "separator" to minimize the dissipation of aggregate into the underlying soil due to construction traffic loads. If the action of the vehicles traveling over the gravel pad is not sufficient to remove the majority of the mud or there exists an especially sensitive traffic situation on the adjacent paved road, the tires must be washed before the vehicle enters the public road. If washing is necessary, provisions must be made to intercept the wash water and trap the sediment so it can be collected and stabilized. Construction entrances should be used in conjunction with the stabilization of construction roads (see Std. & Spec. 3.03, CONSTRUCTION ROAD STABILIZATION) to reduce the amount of mud picked up by construction vehicles and to do a better job of mud removal. Other innovative techniques for accomplishing the same purpose (such as a bituminous entrance) can be utilized, but only after specific plans and details are submitted to and approved by the appropriate Plan-Approving Authority.

Design Criteria

Aggregate Size

VDOT #1 Coarse Aggregate (2- to 3-inch stone) should be used.

Entrance Dimensions

The aggregate layer must be at least 6 inches thick; a minimum three inches of aggregate should be placed in a cut section to give the entrance added stability and to help secure filter cloth separator. It must extend the full width of the vehicular ingress and egress area and have a minimum 12-foot width. The length of the entrance must be at least 70 feet (see Plate 3.02-1).

Washing

If conditions on the site are such that the majority of the mud is not removed by the vehicles traveling over the stone, then the tires of the vehicles must be washed before entering the public road. Wash water must be carried away from the entrance to a approved settling area to remove sediment. All sediment shall be prevented from entering storm drains, ditches, or watercourses. A wash rack may also be used to make washing more convenient and effective (see Plate 3.02-1).

Location

The entrance should be located to provide for maximum utilization by all construction vehicles.

Construction Specifications

The area of the entrance must be excavated a minimum of 3 inches and must be cleared of all vegetation, roots, and other objectionable material. The filter fabric underliner will then be placed the full width and length of the entrance.

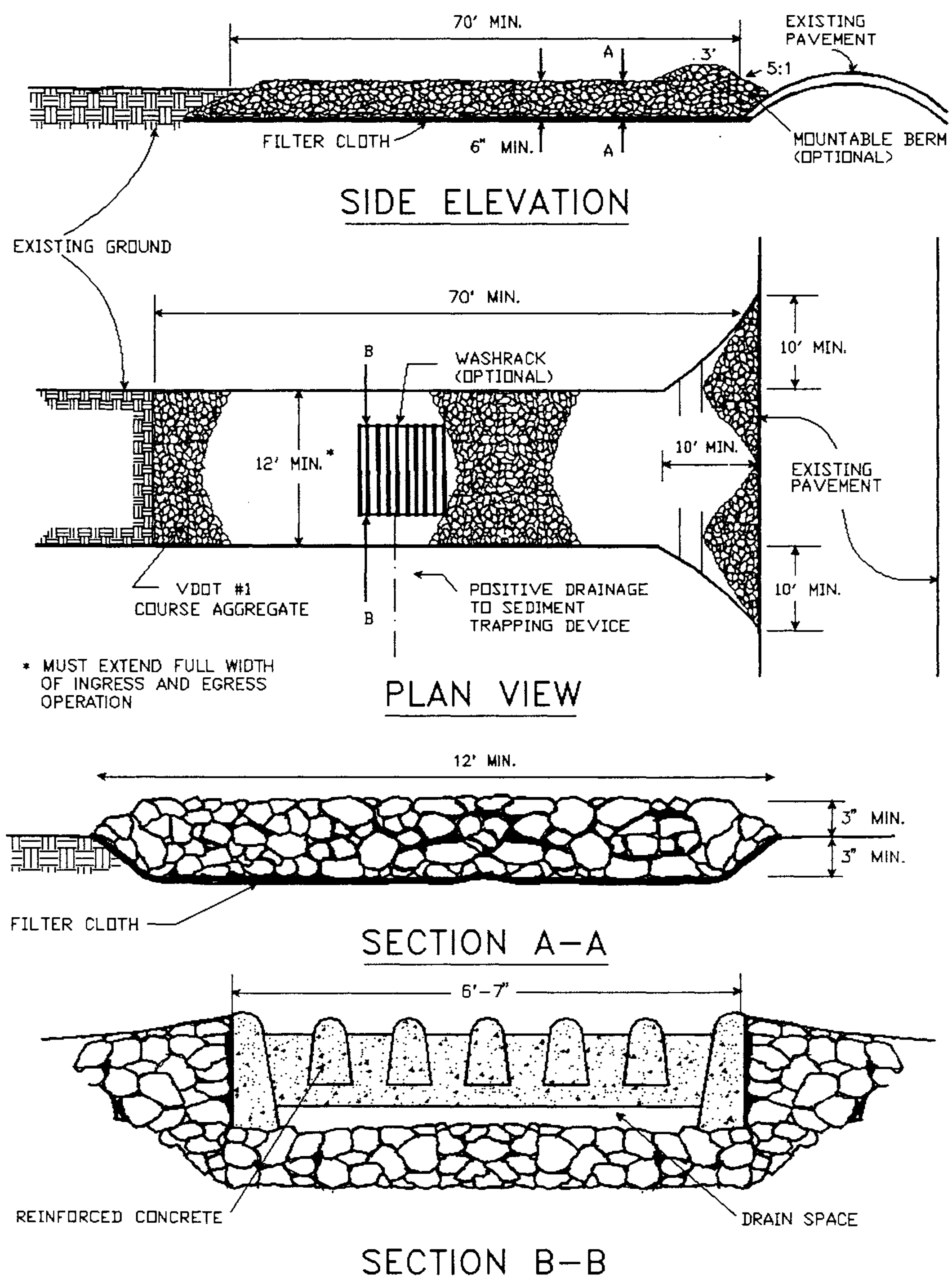
Following the installation of the filter cloth, the stone shall be placed to the specified dimensions. If wash racks are used, they should be installed according to manufacturer's specifications. Any drainage facilities required because of washing should be constructed according to specifications. Conveyance of surface water under entrance, through culverts, shall be provided as required. If such conveyance is impossible, the construction of a "mountable" berm with 5:1 slopes will be permitted.

The filter cloth utilized shall be a woven or nonwoven fabric consisting only of continuous chain polymeric filaments or yarns of polyester. The fabric shall be inert to commonly encountered chemicals and hydrocarbons, be mildew and rot resistant, and conform to the physical properties noted in Table 3.02-A.

Maintenance

The entrance shall be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with additional stone or the washing and reworking of existing stone as conditions demand and repair and/or cleanout of any structures used to trap sediment. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into storm drains must be removed immediately. The use of water trucks to remove materials dropped, washed, or tracked onto roadways will not be permitted under any circumstances.

STONE CONSTRUCTION ENTRANCE



Source: Adapted from 1983 Maryland Standards for Soil Erosion and Sediment Control, and Va. DSWC

Plate 3.02-1

TABLE 3.02-A

CONSTRUCTION SPECIFICATIONS FOR FILTER CLOTH UNDERLINER

Fabric Properties[1]	Light-Duty Entrance[2] (Graded Subgrade)	Heavy-Duty Entrance[3] (Rough Graded)	Test Method
Grab Tensile Strength (lbs.)	200	220	ASTM D1682
Elongation at Failure (%)	50	220	ASTM D1682
Mullen Burst Strength (lbs.)	190	430	ASTM D3786
Puncture Strength (lbs.)	40	125	ASTM D751 (modified)
Equivalent Opening Size (mm)	40-80	40-80	U.S. Standard Sieve CW-02215

[1] Fabrics not meeting these specifications may be used only when design procedure and supporting documentation are supplied to determine aggregate depth and fabric strength.

[2] Light Duty Entrance: Sites that have been graded to subgrade and where most travel would be single axle vehicles and an occasional multi-axle truck. Examples of fabrics which can be used are: Trevira Spunbond 1115, Mirafi 100X, Typar 3401, or equivalent.

[3] Heavy Duty Entrance: Sites with only rough grading and where most travel would be multi-axle vehicles. Examples of fabrics which can be used are: Trevira Spunbond 1135, Mirafi 600X, or equivalent.

Source: Virginia Highway and Transportation Research Council (VHTRC)

STD & SPEC 3.03

CONSTRUCTION ROAD STABILIZATION

CRS

Definition

The temporary stabilization of access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes with stone immediately after grading.

Purposes

1. To reduce the erosion of temporary roadbeds by construction traffic during wet weather.

2. To reduce the erosion and subsequent regrading of permanent roadbeds between the time of initial grading and final stabilization.

Conditions Where Practice Applies

Wherever stone-base roads or parking areas are constructed, whether permanent or temporary, for use by construction traffic.

Planning Considerations

Areas which are graded for construction vehicle transport and parking purposes are especially susceptible to erosion. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires which generate significant quantities of sediment that may pollute nearby streams or be transported off site on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Immediate stabilization of such areas with stone may cost money at the outset, but it may actually save money in the long run by increasing the usefulness of the road during wet weather.

Permanent roads and parking areas should be paved as soon as possible after grading. However, it is understandable that weather conditions or the potential for damage may not make paving feasible in the early phases of the development project. As an alternative, the early application of stone may solve potential erosion and stability problems and eliminate later regrading costs. Some of the stone will also probably remain in place for use as part of the final base course in the construction of the road.

Specifications

Temporary Access Roads and Parking Areas

1. Temporary roads shall follow the contour of the natural terrain to the extent possible. Slopes should not exceed 10 percent.

2. Temporary parking areas should be located on naturally flat areas to minimize grading. Grades should be sufficient to provide drainage but should not exceed 4 percent.

3. Roadbeds shall be at least 14 feet wide for one-way traffic and 20 feet wide for two-way traffic.

4. All cuts and fills shall be 2:1 or flatter to the extent possible.

5. Drainage ditches shall be provided as needed and shall be designed and constructed in accordance with STORMWATER CONVEYANCE CHANNEL, Std. & Spec. 3.17.

6. The roadbed or parking surface shall be cleared of all vegetation, roots and other objectionable material.

7. A 6-inch course of VDOT #1 Coarse Aggregate shall be applied immediately after grading or the completion of utility installation within the right-of-way. Filter fabric may be applied to the roadbed for additional stability. Design specifications for filter fabric can be found within Std. & Spec. 3.02, TEMPORARY STONE CONSTRUCTION ENTRANCE. In "heavy duty" traffic situations (see Table 3.02-A), stone should be placed at an 8- to 10-inch depth to avoid excessive dissipation or maintenance needs.

Permanent Roads and Parking Areas

Permanent roads and parking areas shall be designed and constructed in accordance with applicable VDOT or local criteria except that an initial base course of gravel of at least 6 inches shall be applied immediately following grading.

Vegetation

All roadside ditches, cuts, fills and disturbed areas adjacent to parking areas and roads shall be stabilized with appropriate temporary or permanent vegetation according to the applicable standards and specifications contained in this handbook.

Maintenance

Both temporary and permanent roads and parking areas may require periodic top dressing with new gravel. Seeded areas adjacent to the roads and parking areas should be checked periodically to ensure that a vigorous stand of vegetation is maintained. Roadside ditches and other drainage structures should be checked regularly to ensure that they do not become clogged with silt or other debris.

STD & SPEC 3.05

x—x—x—x

SILT FENCE

SF

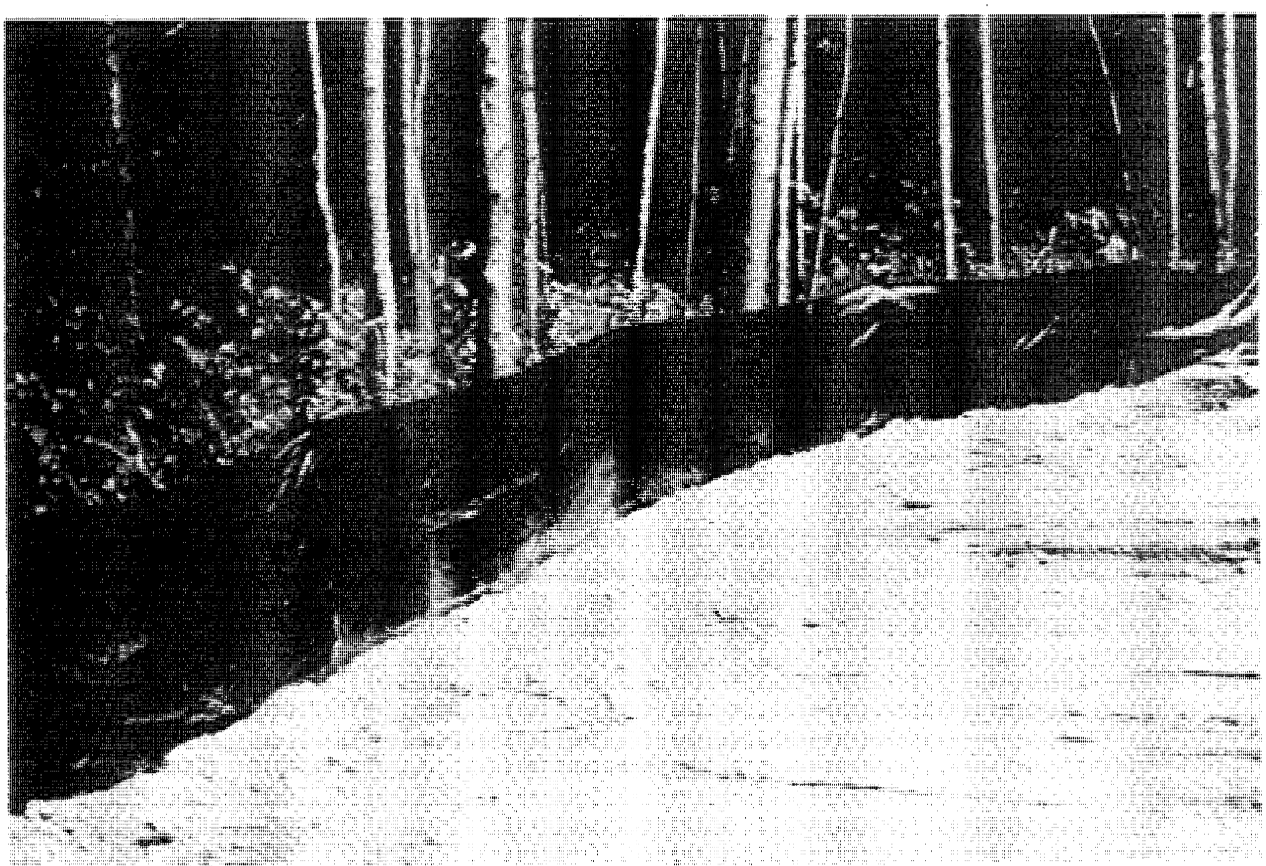
Definition

A temporary sediment barrier consisting of a synthetic filter fabric stretched across and attached to supporting posts and entrenched.

Purposes

1. To intercept and detain small amounts of sediment from disturbed areas during construction operations in order to prevent sediment from leaving the site.

2. To decrease the velocity of sheet flows and low-to-moderate level channel flows.



Conditions Where Practice Applies

1. Below disturbed areas where erosion would occur in the form of sheet and rill erosion.

2. Where the size of the drainage area is no more than one quarter acre per 100 feet of silt fence length; the maximum slope length behind the barrier is 100 feet; and the maximum gradient behind the barrier is 50 percent (2:1).

3. In minor swales or ditch lines where the maximum contributing drainage area is no greater than 1 acre and flow is no greater than 1 cfs.

4. Silt fence will not be used in areas where rock or some other hard surface prevents the full and uniform depth anchoring of the barrier.

Planning Considerations

Laboratory work at the Virginia Highway and Transportation Research Council (VHTRC) has shown that silt fences can trap a much higher percentage of suspended sediments than straw bales, though silt fence passes the sediment-laden water slower. Silt fences are preferable to straw barriers in many cases because of their durability and potential cost savings. While the failure rate of silt fences is lower than that of straw barriers, many instances have been observed where silt fences are improperly installed, inviting failure and sediment loss. The installation methods outlined here can improve performance and reduce failures.

As noted, flow rate through silt fence is significantly lower than the flow rate for straw bale barriers. This creates more ponding and hence more time for sediment to fall out. Table 3.05-A demonstrates these relationships.

Both woven and non-woven synthetic fabrics are commercially available. The woven fabrics generally display higher strength than the non-woven fabrics and, in most cases, do not require any additional reinforcement. When tested under acid and alkaline water conditions, most of the woven fabrics increase in strength, while the reactions of non-woven fabrics to these conditions are variable. The same is true of testing under extensive ultraviolet radiation. Permeability rates vary regardless of fabric type. While all of the fabrics demonstrate very high filtering efficiencies for sandy sediments, there is considerable variation among both woven and non-woven fabrics when filtering the finer silt and clay particles.

Design Criteria

1. No formal design is required. As with straw bale barriers, an effort should be made to locate silt fence at least 5 feet to 7 feet beyond the base of disturbed slopes with grades greater than 7%.

TABLE 3.05-A

TYPICAL FLOW RATES AND FILTERING EFFICIENCIES OF PERIMETER CONTROL

Material	Flow Rate (gal./sq.ft./min)	Filter Efficiency(%)
Straw	5.6	67
Synthetic Fabric	0.3	97

Source: VHTRC

2. The use of silt fences, because they have such a low permeability, is limited to situations in which only sheet or overland flows are expected and where concentrated flows originate from drainage areas of 1 acre or less.

3. Field experience has demonstrated that, in many instances, silt fence is installed too short (less than 16 inches above ground elevation). The short fence is subject to breaching during even small storm events and will require maintenance "clean outs" more often. Properly supported silt fence which stands 24 to 34 inches above the existing grade tends to promote more effective sediment control.

Construction Specifications

Materials

1. Synthetic filter fabric shall be a pervious sheet of propylene, nylon, polyester or ethylene yarn and shall be certified by the manufacturer or supplier as conforming to the requirements noted in Table 3.05-B.

2. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0° F to 120° F.

3. If wooden stakes are utilized for silt fence construction, they must have a diameter of 2 inches when oak is used and 4 inches when pine is used. Wooden stakes must have a minimum length of 5 feet.

TABLE 3.05-B

PHYSICAL PROPERTIES OF FILTER FABRIC IN SILT FENCE

Physical Property	Test	Requirements
Filtering Efficiency	ASTM 5141	75% (minimum)
Tensile Strength at 20% (max.) Elongation*	VTM-52	Extra Strength - 50 lbs./linear inch (minimum) Standard Strength - 30 lbs./linear inch (minimum)
Flow Rate	ASTM 5141	0.2 gal./sq.ft./ minute (minimum)
Ultraviolet Radiation Stability %	ASTM-G-26	90% (minimum)

* Requirements reduced by 50% after six months of installation.

Source: VHTRC

4. If steel posts (standard "U" or "T" section) are utilized for silt fence construction, they must have a minimum weight of 1.33 pounds per linear foot and shall have a minimum length of 5 feet.

5. Wire fence reinforcement for silt fences using standard-strength filter cloth shall be a minimum of 14 gauge and shall have a maximum mesh spacing of 6 inches.

Installation

1. The height of a silt fence shall be a minimum of 16 inches above the original ground surface and shall not exceed 34 inches above ground elevation.

2. The filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter cloth shall be spliced together only at a support post, with a minimum 6-inch overlap, and securely sealed.

3. A trench shall be excavated approximately 4-inches wide and 4-inches deep on the upslope side of the proposed location of the measure.

4. When wire support is used, standard-strength filter cloth may be used. Posts for this type of installation shall be placed a maximum of 10-feet apart (see Plate 3.05-1). The wire mesh fence must be fastened securely to the upslope side of the posts using heavy duty wire staples at least one inch long, tie wires or hog rings. The wire shall extend into the trench a minimum of two inches and shall not extend more than 34 inches above the original ground surface. The standard-strength fabric shall be stapled or wired to the wire fence, and 8 inches of the fabric shall be extended into the trench. The fabric shall not be stapled to existing trees.

5. When wire support is not used, extra-strength filter cloth shall be used. Posts for this type of fabric shall be placed a maximum of 6-feet apart (see Plate 3.05-2). The filter fabric shall be fastened securely to the upslope side of the posts using one inch long (minimum) heavy-duty wire staples or tie wires and eight inches of the fabric shall be extended into the trench. The fabric shall not be stapled to existing trees. This method of installation has been found to be more commonplace than #4.

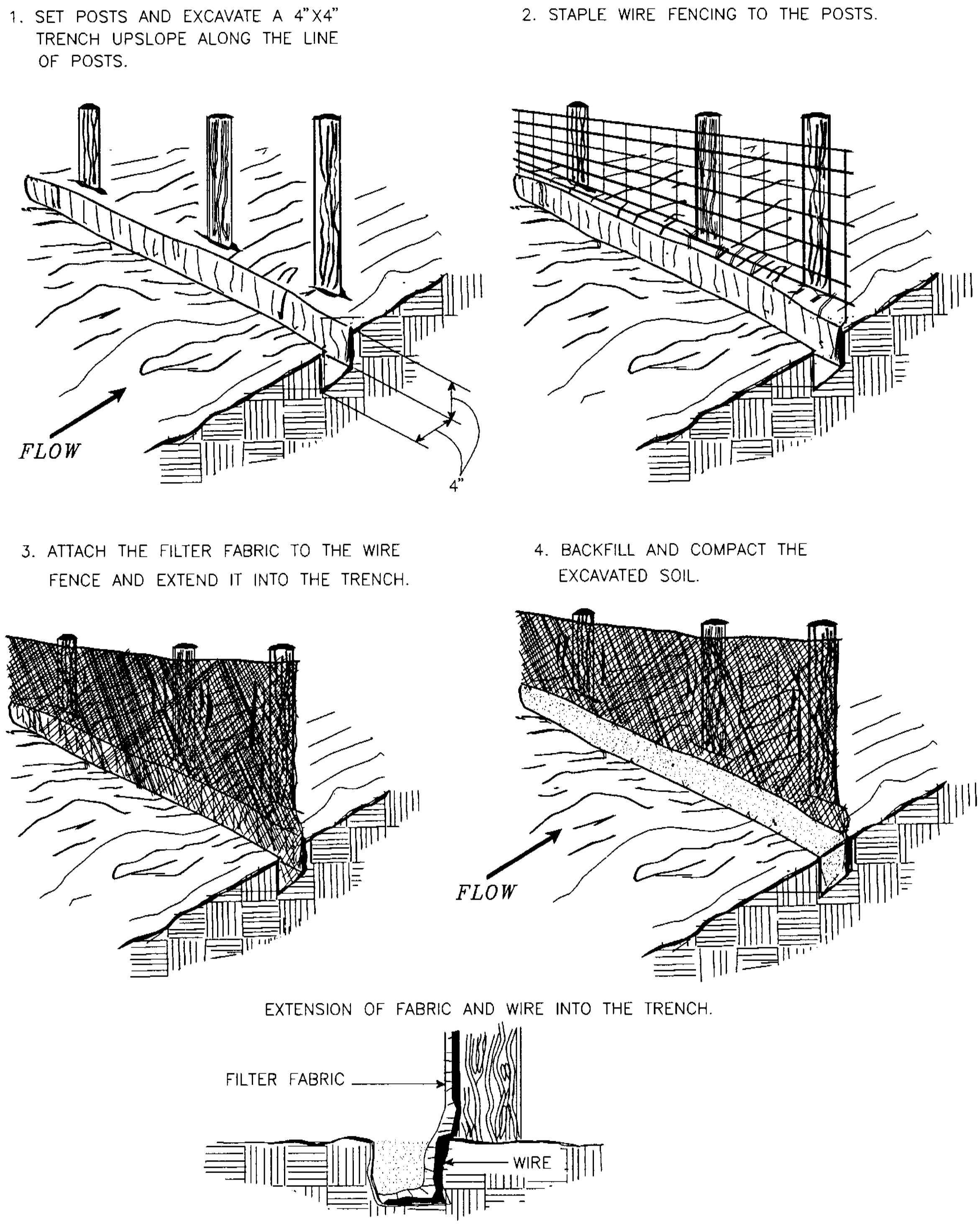
6. If a silt fence is to be constructed across a ditch line or swale, the measure must be of sufficient length to eliminate endflow, and the plan configuration shall resemble an arc or horseshoe with the ends oriented upslope (see Plate 3.05-2). Extra-strength filter fabric shall be used for this application with a maximum 3-foot spacing of posts.

   All other installation requirements noted in #5 apply.

7. The 4-inch by 4-inch trench shall be backfilled and the soil compacted over the filter fabric.

8. Silt fences shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.

CONSTRUCTION OF A SILT FENCE (WITH WIRE SUPPORT)

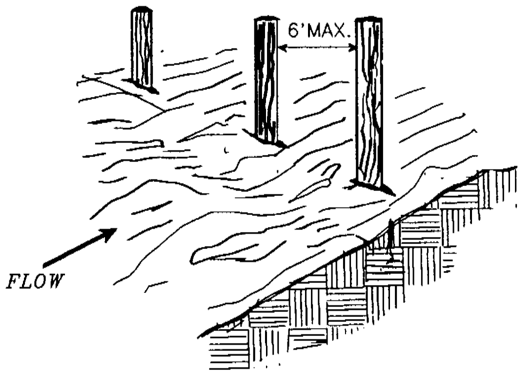


Source: Adapted from <u>Installation of Straw and Fabric Filter Barriers for Sediment Control</u>, Sherwood and Wyant

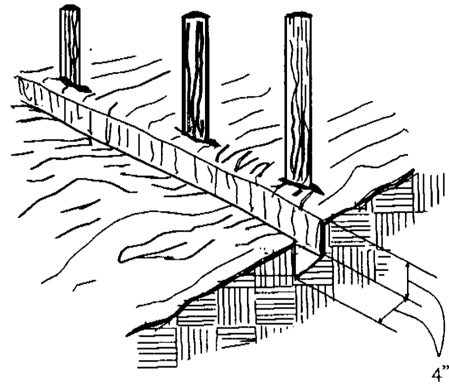
Plate 3.05-1

CONSTRUCTION OF A SILT FENCE (WITHOUT WIRE SUPPORT)

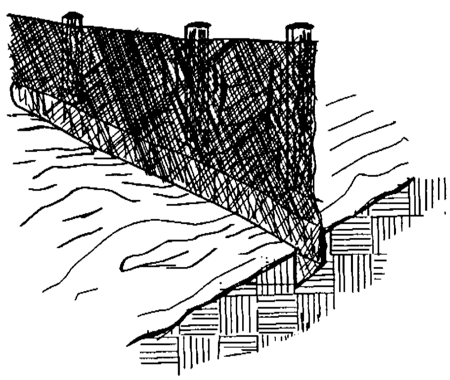
1. SET THE STAKES.



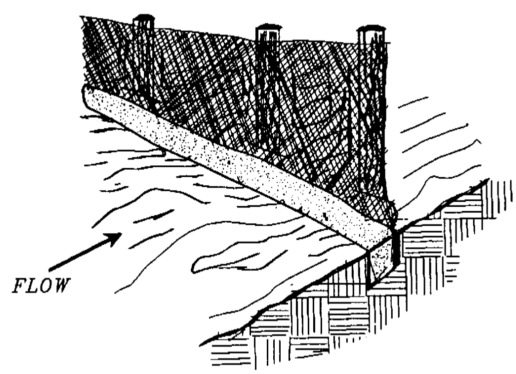
2. EXCAVATE A 4"X 4" TRENCH UPSLOPE ALONG THE LINE OF STAKES.



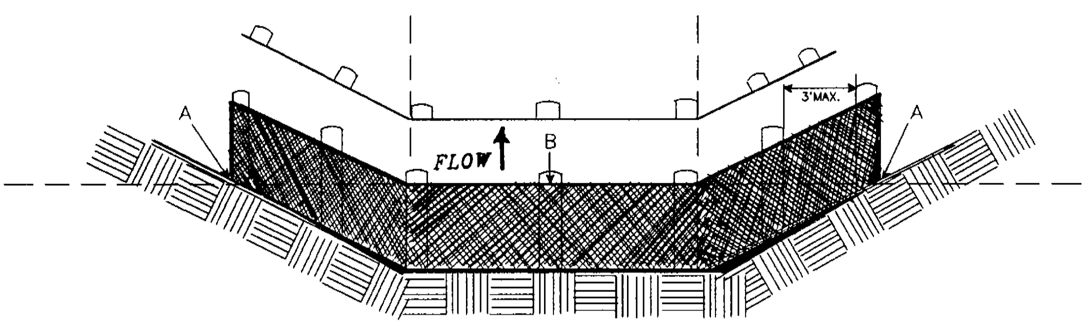
3. STAPLE FILTER MATERIAL TO STAKES AND EXTEND IT INTO THE TRENCH.



4. BACKFILL AND COMPACT THE EXCAVATED SOIL.



SHEET FLOW INSTALLATION
(PERSPECTIVE VIEW)



POINTS A SHOULD BE HIGHER THAN POINT B.

DRAINAGEWAY INSTALLATION
(FRONT ELEVATION)

Source: Adapted from Installation of Straw and Fabric Filter Barriers for Sediment Control, Sherwood and Wyant

Plate 3.05-2

Maintenance

1. Silt fences shall be inspected immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs shall be made immediately.

2. Close attention shall be paid to the repair of damaged silt fence resulting from end runs and undercutting.

3. Should the fabric on a silt fence decompose or become ineffective prior to the end of the expected usable life and the barrier still be necessary, the fabric shall be replaced promptly.

4. Sediment deposits should be removed after each storm event. They must be removed when deposits reach approximately one-half the height of the barrier.

5. Any sediment deposits remaining in place after the silt fence is no longer required shall be dressed to conform with the existing grade, prepared and seeded.

STD & SPEC 3.09

TEMPORARY DIVERSION DIKE

DD

Definition

A temporary ridge of compacted soil constructed at the top or base of a sloping disturbed area.

Purposes

1. To divert storm runoff from upslope drainage areas away from unprotected disturbed areas and slopes to a stabilized outlet.

2. To divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or sediment basin.

Conditions Where Practice Applies

Wherever stormwater runoff must be temporarily diverted to protect disturbed areas and slopes or retain sediment on site during construction. These structures generally have a life expectancy of 18 months or less, which can be prolonged with proper maintenance.

Planning Considerations

A temporary diversion dike is intended to divert overland sheet flow to a stabilized outlet or a sediment-trapping facility during establishment of permanent stabilization on sloping disturbed areas. When used a the top of a slope, the structure protects exposed slopes by keeping upland runoff away. When used at the base of a slope, the structure protects adjacent and downstream areas by diverting sediment-laden runoff to a sediment trapping facility.

As per M.S. #5, it is very important that a temporary diversion dike be stabilized immediately following installation with temporary or permanent vegetation to prevent erosion of the dike itself. The gradient of the channel behind the dike is also an important consideration. The dike must have a positive grade to assure drainage, but if the gradient is too great, precautions must be taken to prevent erosion due to high-velocity channel flow behind the dike. The cross-section of the channel which runs behind the dike should be of a parabolic or trapezoidal shape to help inhibit a high velocity of flow which could arise in a vee ditch.

This practice is considered an economical one because it uses material available on the site and can usually be constructed with equipment needed for site grading. The useful life of the practice can be extended by stabilizing the dike with vegetation. Diversion dikes are preferable to silt fence because they are more durable, less expensive, and require much less maintenance when constructed properly. Along with a TEMPORARY SEDIMENT TRAP (Std. & Spec. 3.13), they become a logical choice for a control measure once the control limits of the silt fence or straw bale barrier have been exceeded.

Temporary diversion dikes are often used as a perimeter control in association with a sediment trap or a sediment basin, or a series of sediment-trapping facilities, on moderate to large construction sites. If installed properly and in the first phase of grading, maintenance costs are very low. Often, cleaning of sediment-trapping facilities is the only associated maintenance requirement.

As specified herein, this practice is intended to be temporary. However, with more stringent design criteria, it can be made permanent in accordance with DIVERSIONS (Std. & Spec. 3.12).

Design Criteria

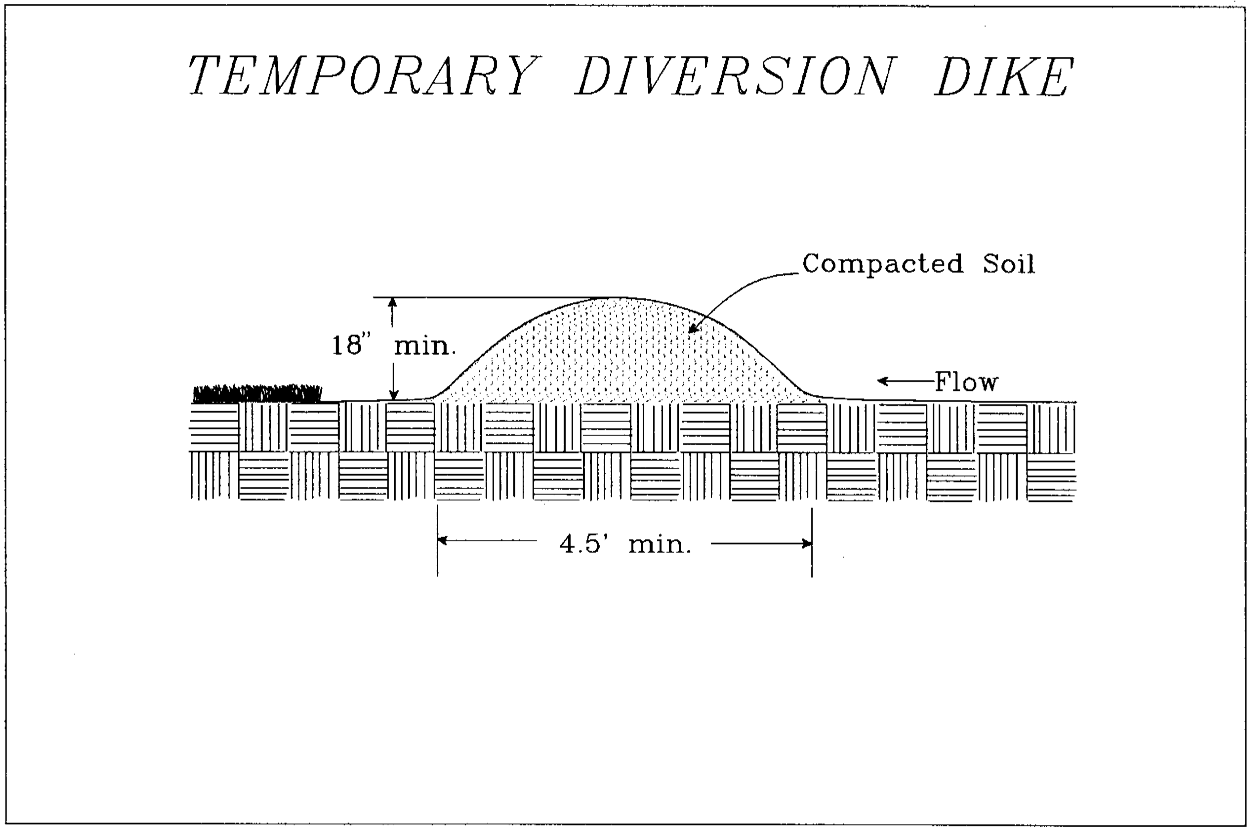
No formal design is required. The following criteria shall be met:

Drainage Area

The maximum allowable drainage area is 5 acres.

Height

The minimum allowable height measured from the upslope side of the dike is 18 inches (see Plate 3.09-1).



Source: Va. DSWC

Plate 3.09-1

Side Slopes

1½:1 or flatter, along with a minimum base width of 4.5 feet (see Plate 3.09-1).

Grade

The channel behind the dike shall have a positive grade to a stabilized outlet. If the channel slope is less than or equal to 2%, no stabilization is required. If the slope is greater than 2%, the channel shall be stabilized in accordance with Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNEL.

Outlet

1. The diverted runoff, if free of sediment, must be released through a stabilized outlet or channel.

2. Sediment-laden runoff must be diverted and released through a sediment-trapping facility such as a TEMPORARY SEDIMENT TRAP (Std. & Spec. 3.13) or TEMPORARY SEDIMENT BASIN (Std. & Spec. 3.14).

Construction Specifications

1. Temporary diversion dikes must be installed as a first step in the land-disturbing activity and must be functional prior to upslope land disturbance.

2. The dike should be adequately compacted to prevent failure.

3. Temporary or permanent seeding and mulch shall be applied to the dike immediately following its construction.

4. The dike should be located to minimize damages by construction operations and traffic.

Maintenance

The measure shall be inspected after every storm and repairs made to the dike, flow channel, outlet or sediment trapping facility, as necessary. Once every two weeks, whether a storm event has occurred or not, the measure shall be inspected and repairs made if needed. Damages caused by construction traffic or other activity must be repaired before the end of each working day.

STD & SPEC 3.11

TEMPORARY RIGHT-OF-WAY DIVERSION

RWD

Definition

A ridge of compacted soil or loose rock or gravel constructed across disturbed rights-of-way and similar sloping areas.

Purpose

To shorten the flow length within a sloping right-of-way, thereby reducing the erosion potential by diverting storm runoff to a stabilized outlet.

Conditions Where Practice Applies

Generally, earthen diversions are applicable where there will be little or no construction traffic within the right-of-way. Gravel structures are more applicable to roads and other rights-of-way which accommodate vehicular traffic.

Planning Considerations

Construction of utility lines and roads often requires the clearing of long strips of right-of-way over sloping terrain. The volume and velocity of stormwater runoff tend to increase in these cleared strips and the potential for erosion is much greater since the vegetative cover is diminished or removed. To compensate for the loss of vegetation, it is usually a good practice to break up the flow length within the cleared strip so that runoff does not have a chance to concentrate and cause erosion. At proper intervals, temporary right-of-way diversions can significantly reduce the amount of erosion which will occur until the area is permanently stabilized. Since many right-of-ways are constructed through heavily vegetated areas, runoff can often be diverted into a vegetative buffer strip (if it provides a minimum flow length of 75 feet).

Design Criteria

No formal design is required. The following criteria shall be met:

Height

The minimum allowable height of the diversion is 18 inches (see Plate 3.11-1).

Side Slopes

Side slopes should be 2:1 or flatter to allow the passage of construction traffic, along with a minimum base width of 6 feet (see Plate 3.11-1).

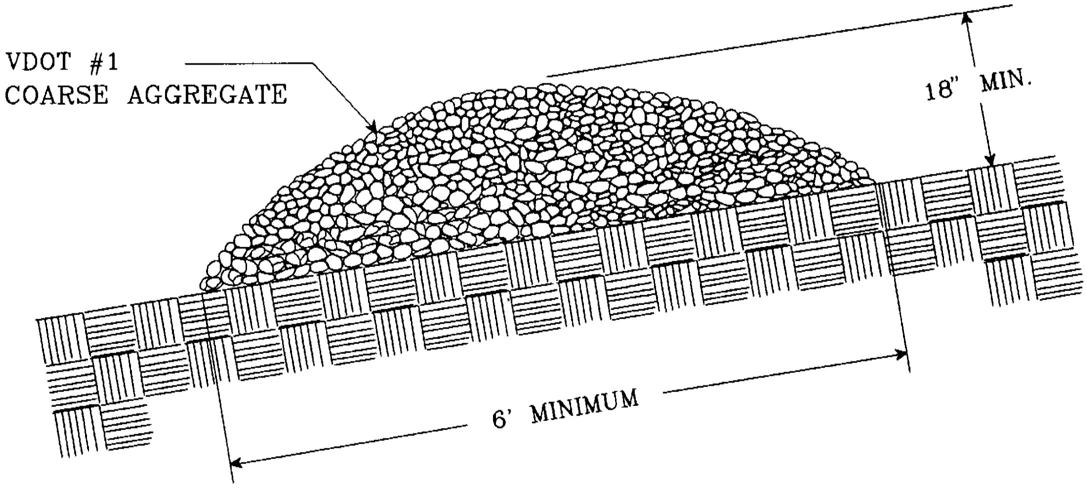
Width

The measure should be constructed completely across the disturbed portion of the right-of-way.

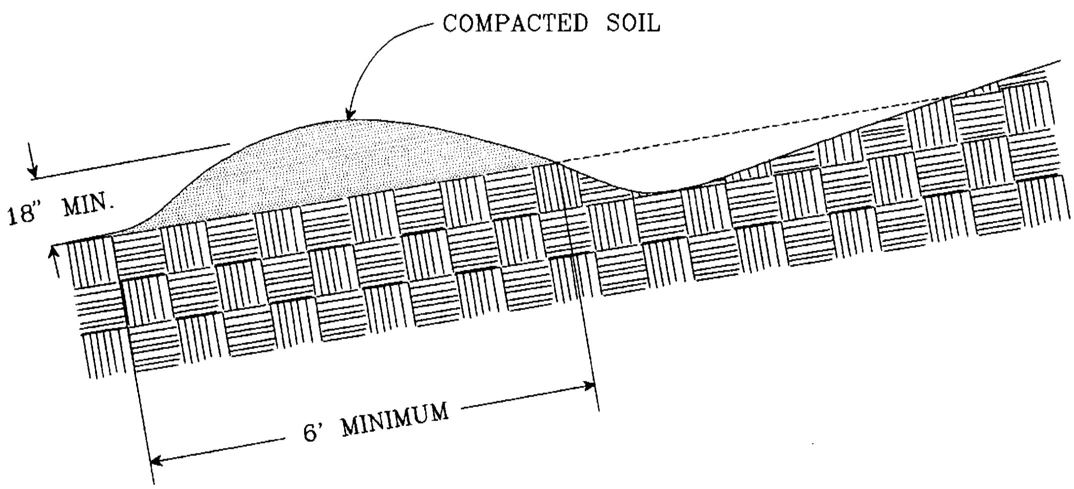
Spacing

Table 3.11-A will be used to determine the spacing of right-of-way diversions.

TEMPORARY RIGHT-OF-WAY DIVERSIONS



TYPICAL GRAVEL STRUCTURE



TYPICAL EARTHEN STRUCTURE

Source: Va. DSWC

Plate 3.11-1

TABLE 3.11-A

SPACING OF RIGHT-OF-WAY DIVERSIONS

% Slope	Spacing (ft.)
Less than 7%	100
Between 7% and 25%	75
Between 25% and 40%	50
Greater than 40%	25

Source: Va. DSWC

Grade

Positive drainage (with less than 2% slope) should be provided to a stabilized outlet, sediment-trapping facility, or a vegetative buffer strip of adequate size.

Outlet

Interceptor dikes must have an outlet which is not subject to erosion.

The on-site location may need to be adjusted to meet field conditions in order to utilize the most suitable outlet. Concentrated flows should spread over the widest possible area after release. Flows with high sediment concentrations should pass through an appropriate sediment-trapping measure.

Construction Specifications

1. The diversion shall be installed as soon as the right-of-way has been cleared and/or graded.

2. All earthen diversions shall be machine- or hand-compacted in 8-inch lifts.

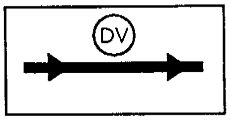
3. The outlet of the diversion shall be located on an undisturbed and stabilized area when at all possible. The field location should be adjusted as needed to utilize a stabilized outlet.

4. Earthen diversions which will not be subject to construction traffic should be stabilized in accordance with TEMPORARY SEEDING (Std. & Spec. 3.31).

Maintenance

The practice shall be inspected after every rainfall and repairs made if necessary. At least once every two weeks, whether a storm has occurred or not, the measure shall be inspected and repairs made if needed. Right-of-way diversions, which are subject to damage by vehicular traffic, should be reshaped at the end of each working day.

STD & SPEC 3.12



DIVERSION

DV

Definition

A channel constructed across a slope with a supporting earthen ridge on the lower side.

Purpose

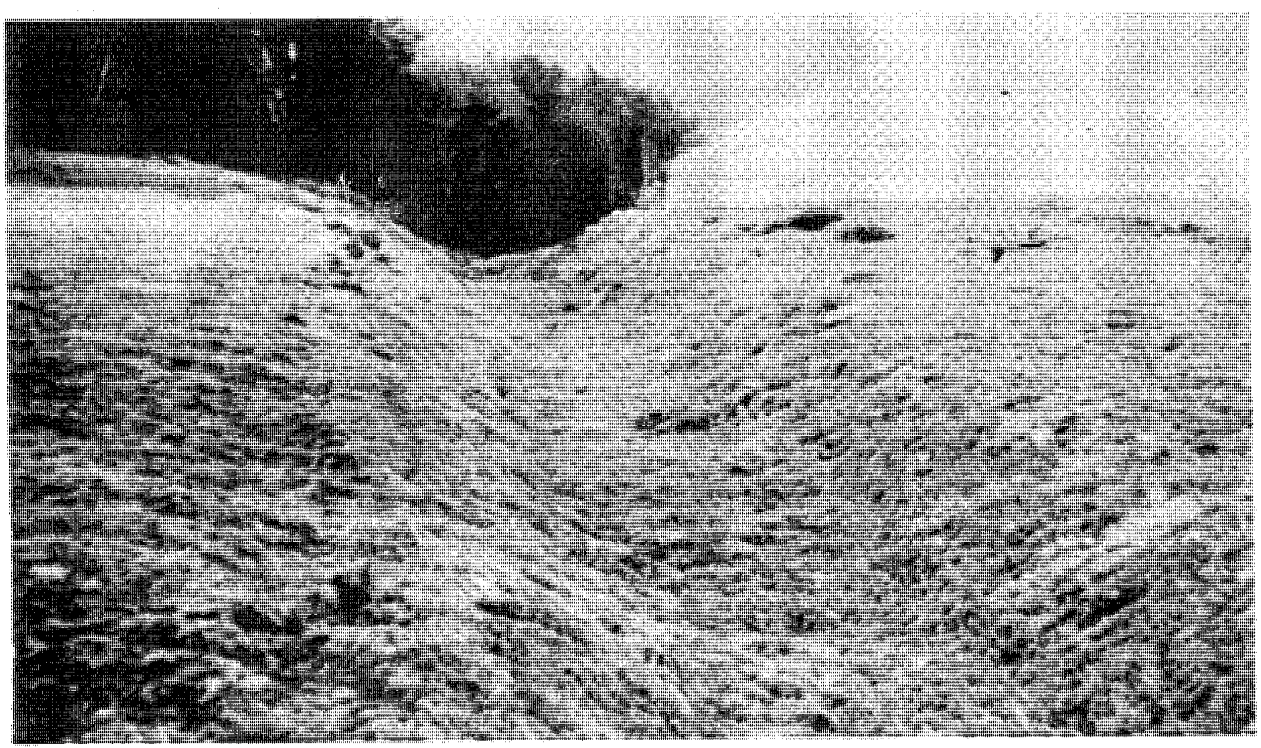
To reduce slope length and to intercept and divert stormwater runoff to stabilized outlets at non-erosive velocities.

Conditions Where Practice Applies

1. Where runoff from areas of higher elevation may damage property, cause erosion, or interfere with the establishment of vegetation on lower areas.

2. Where surface and/or shallow subsurface flow is damaging sloping upland.

3. Where the slope length needs to be reduced to minimize soil loss.



Planning Considerations

Diversions can be useful tools for managing surface water flows and preventing soil erosion. On moderately sloping areas, they may be placed at intervals to trap and divert sheet flow before it has a chance to concentrate and cause rill and gully erosion. They may be placed at the top of cut or fill slopes to keep runoff from upland drainage areas off the slope. They can also be used to protect structures, parking lots, adjacent properties, and other special areas from flooding.

Diversions are preferable to other types of man-made stormwater conveyance systems because they more closely simulate natural flow patterns and characteristics. Flow velocities are generally kept to a minimum. When properly coordinated into the landscape design of a site, diversions can be visually pleasing as well as functional.

As with any earthen structure, it is very important to establish adequate vegetation as soon as possible after installation. It is equally important to stabilize the drainage area above the diversion so that sediment will not enter and accumulate in the diversion channel.

Design Criteria

Location

Diversion location shall be determined by considering outlet conditions, topography, land use, soil type, length of slope, seepage planes (where seepage is a problem) and the development layout.

Capacity

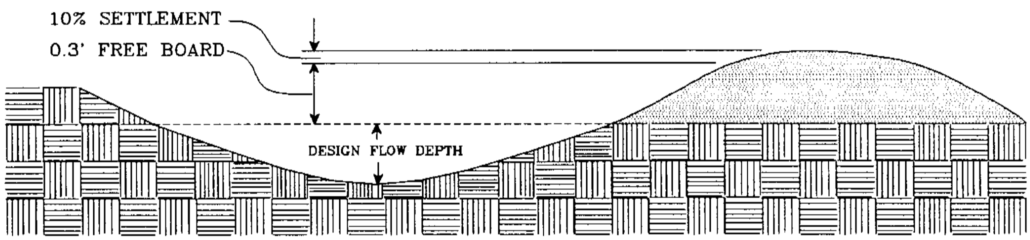
1. The diversion channel must have a minimum capacity to carry the runoff expected from a 10-year frequency storm with a freeboard of at least 0.3 foot (see Plate 3.12-1).

2. Diversions designed to protect homes, schools, industrial buildings, roads, parking lots, and comparable high-risk areas, and those designed to function in connection with other structures, shall have sufficient capacity to carry peak runoff expected from a storm frequency consistent with the hazard involved.

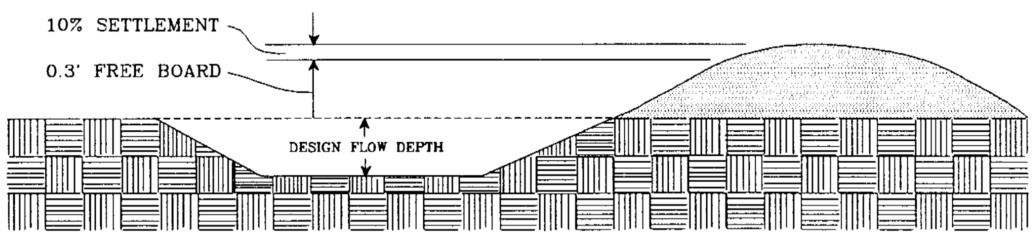
Channel Design

The diversion channel may be parabolic, trapezoidal or vee-shaped and shall be designed and constructed according to Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNELS.

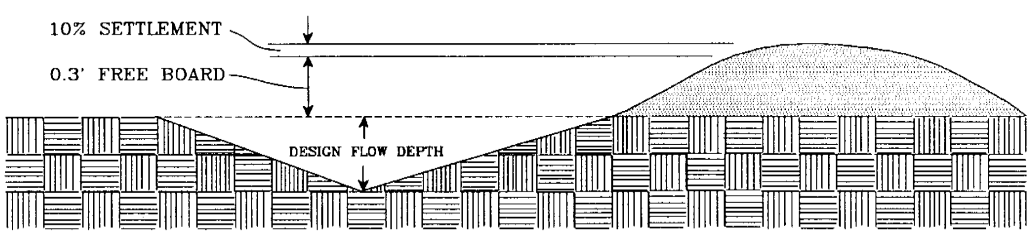
DIVERSIONS



TYPICAL PARABOLIC DIVERSION



TYPICAL TRAPEZOIDAL DIVERSION



TYPICAL VEE-SHAPED DIVERSION

Source: Va. DSWC

Plate 3.12-1

Ridge Design

The supporting ridge cross-section shall meet the following criteria (see Plate 3.12-1):

1. The side slopes shall be no steeper than 2:1.

2. The width at the design water elevation shall be a minimum of 4 feet.

3. The minimum freeboard shall be 0.3 foot.

4. The design shall include a 10 percent settlement factor.

Outlet

Diversions shall have adequate outlets which will convey concentrated runoff without erosion. Acceptable outlets include STORMWATER CONVEYANCE CHANNEL (Std. & Spec. 3.17); LEVEL SPREADER (Std. & Spec. 3.21); OUTLET PROTECTION (Std. & Spec. 3.18); and PAVED FLUME (Std. & Spec. 3.16).

Stabilization

1. The ridge and channel shall be seeded and mulched immediately following their construction in accordance with Std. & Spec. 3.32, PERMANENT SEEDING.

2. Disturbed areas draining into the diversion should normally be seeded and mulched prior to the time the diversion is constructed. Sediment trapping measures must remain in place to prevent soil movement into the diversion if upslope area is not stabilized.

Construction Specifications

1. All trees, brush, stumps, obstructions, and other objectionable material shall be removed and disposed of so as not to interfere with the proper functioning of the diversion.

2. The diversion shall be excavated or shaped to line, grade, and cross-section as required to meet the criteria specified herein, free of irregularities which will impede flow.

3. Fills shall be compacted as needed to prevent unequal settlement that would cause damage in the completed diversion. Fill shall be composed of soil which is free from excessive organic debris, rocks or other objectionable materials.

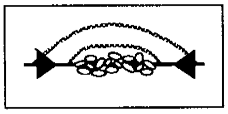
4. All earth removed and not needed in construction shall be spread or disposed of so that it will not interfere with the functioning of the diversion.

5. Permanent stabilization of disturbed areas shall be done in accordance with the applicable standard and specification contained in this handbook. Permanent stabilization techniques include PERMANENT SEEDING (Std. & Spec. 3.32).

Maintenance

Before final stabilization, the diversion should be inspected after every rainfall and at least once every two weeks. Sediment shall be removed from the channel and repairs made as necessary. Seeded areas which fail to establish a vegetative cover shall be reseeded as necessary.

STD & SPEC 3.13



TEMPORARY SEDIMENT TRAP

ST

Definition

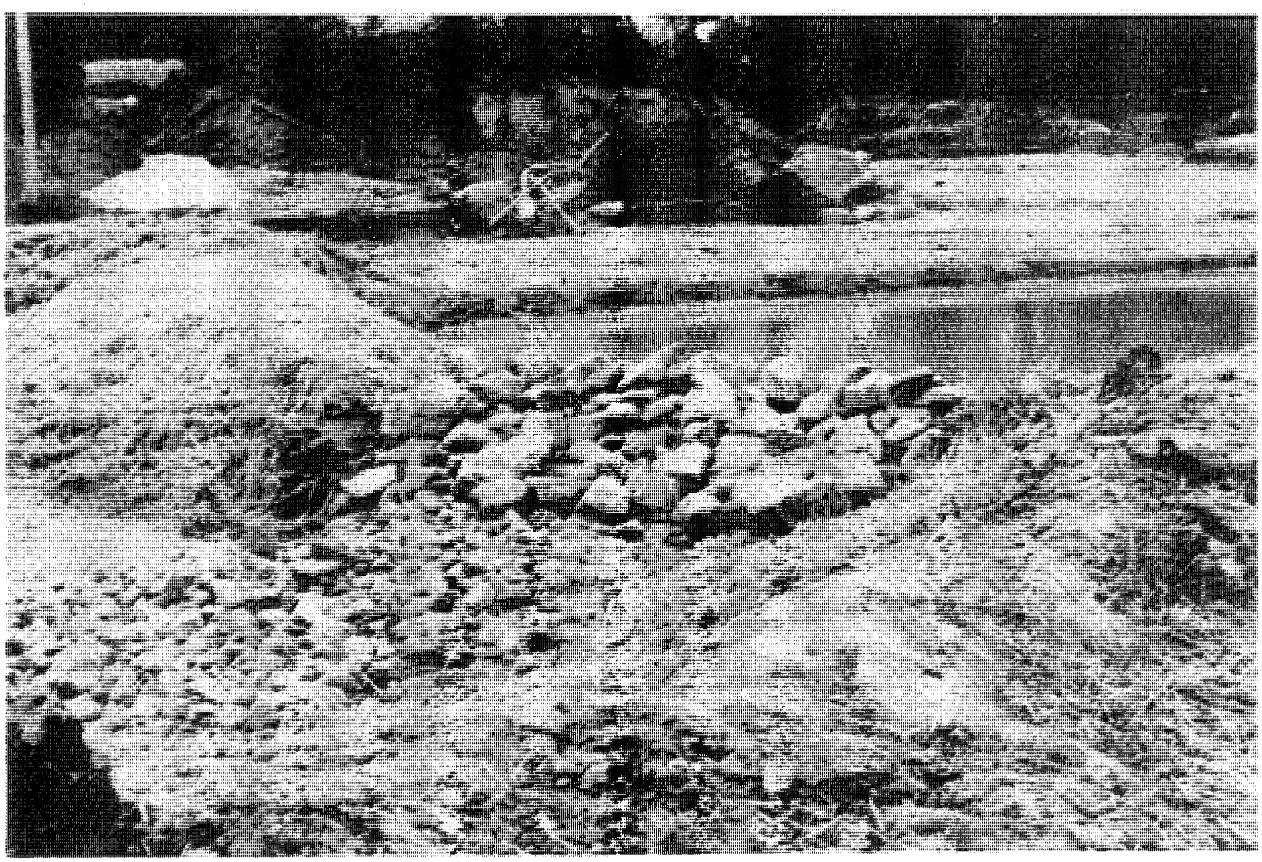
A temporary ponding area formed by constructing an earthen embankment with a stone outlet.

Purpose

To detain sediment-laden runoff from small disturbed areas long enough to allow the majority of the sediment to settle out.

Conditions Where Practice Applies

1. Below disturbed areas where the total contributing drainage area is less than 3 acres.



2. Where the sediment trap will be used no longer than 18 months (the maximum useful life is 18 months).

3. The sediment trap may be constructed either independently or in conjunction with a TEMPORARY DIVERSION DIKE (Std. & Spec. 3.09).

Planning Considerations

Sediment traps should be used only for small drainage areas. If the contributing drainage area is 3 acres or greater, refer to SEDIMENT BASIN (Std. & Spec. 3.14).

Sediment traps, along with other perimeter controls intended to trap sediment, shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

Recent studies have been conducted on the performance of sediment traps (and basins) which were constructed using the design criteria found in previous editions of this handbook. The studies indicate that the control measures only achieved a 46% removal of sediment which flowed into them during storm events which caused measurable outflow. To achieve a more acceptable removal rate (60%), it was necessary to revise the design of these measures in this handbook. The total initial storage volume for both the sediment trap and the TEMPORARY SEDIMENT BASIN (Std. & Spec. 3.14) has been doubled. There are both a "wet" storage volume and a drawdown or "dry" storage volume which help to enhance sediment fall-out and prevent excessive sediment losses during large storm events which occur during the advanced stages of land disturbance (28).

In most cases excavation will be required to attain the necessary storage volume. Also, sediment must be periodically removed from the trap to maintain the required volume. Plans should detail how excavated sediment is to be disposed of, such as by use in fill areas on site or removal to an approved off-site location.

As noted previously in this handbook, there are numerous other acceptable ways to design many of the erosion control practices within. This is certainly true in the case of the sediment trap. However, variations in its design should be considered judiciously by plan reviewers to ensure that the minimum storage requirements and structural integrity noted in this specification are maintained.

Design Criteria

Trap Capacity

The sediment trap must have an initial storage volume of 134 cubic yards per acre of drainage area, half of which shall be in the form of a permanent pool or wet storage to provide a stable settling medium. The remaining half shall be in the form of a drawdown or dry storage which will provide extended settling time during less frequent, larger storm events. The volume of the wet storage shall be measured from the low point of the excavated area to the base of the stone outlet structure. The volume of the dry storage shall be measured from the base of the stone outlet to the crest of the stone outlet (overflow mechanism). Sediment should be removed from the basin when the volume of the wet storage is reduced by one-half.

For a sediment trap, the wet storage volume may be approximated as follows:

$$V_1 = 0.85 \times A_1 \times D_1$$

where,

V_1 = the wet storage volume in cubic feet

A_1 = the surface area of the flooded area at the base of the stone outlet in square feet

D_1 = the maximum depth in feet, measured from the low point in the trap to the base of the stone outlet

The dry storage volume may be approximated as follows:

$$V_2 = \frac{A_1 + A_2}{2} \times D_2$$

where,

V_2 = the dry storage volume in cubic feet

A_1 = the surface area of the flooded area at the base of the stone outlet in square feet

A_2 = the surface area of the flooded area at the crest of the stone outlet (overflow mechanism), in square feet

D_2 = the depth in feet, measured from the base of the stone outlet to the crest of the stone outlet

The designer should seek to provide a storage area which has a minimum 2:1 length to width ratio (measured from point of maximum runoff introduction to outlet).

Note: Conversion between cubic feet and cubic yards is as follows:

number of cubic feet x 0.037 = number of cubic yards

Excavation

Side slopes of excavated areas should be no steeper than 1:1. The maximum depth of excavation within the wet storage area should be 4 feet to facilitate clean-out and for site safety considerations.

Outlet

The outlet for the sediment trap shall consist of a stone section of the embankment located at the low point in the basin. A combination of coarse aggregate and riprap shall be used to provide for filtering/detention as well as outlet stability. The smaller stone shall be VDOT #3, #357, or #5 Coarse Aggregate (smaller stone sizes will enhance filter efficiency) and riprap shall be "Class I." Filter cloth which meets the physical requirements noted in Std. & Spec. 3.19, RIPRAP shall be placed at the stone-soil interface to act as a "separator." The minimum length of the outlet shall be 6 feet times the number of acres comprising the total area draining to the trap. The crest of the stone outlet must be at least 1.0 foot below the top of the embankment to ensure that the flow will travel over the stone and not the embankment. The outlet shall be configured as noted in Plate 3.13-2.

Embankment Cross-Section

The maximum height of the sediment trap embankment shall be 5 feet as measured from the base of the stone outlet. Minimum top widths (W) and outlet heights (Ho) for various embankment heights (H) are shown in Plate 3.13-1. Side slopes of the embankment shall be 2:1 or flatter.

Removal

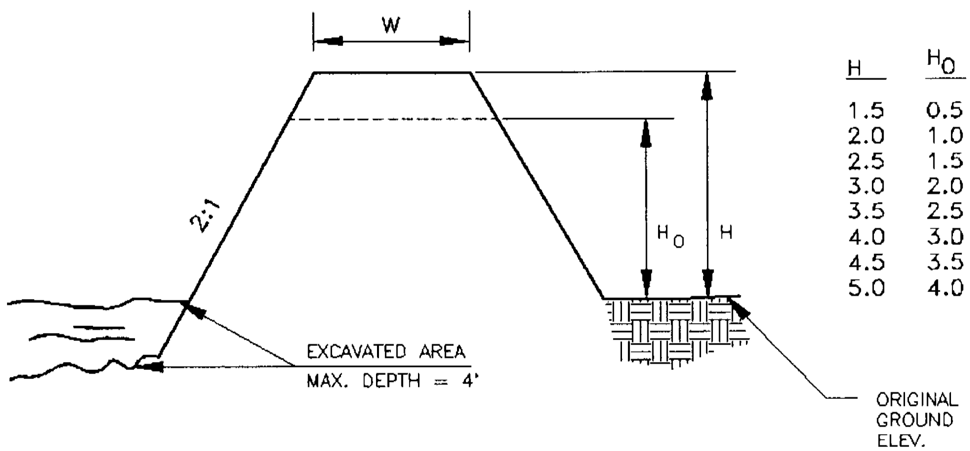
Sediment traps must be removed after the contributing drainage area is stabilized. Plans should show how the site of the sediment trap is to be graded and stabilized after removal.

Construction Specifications

1. The area under the embankment shall be cleared, grubbed, and stripped of any vegetation and root mat.

2. Fill material for the embankment shall be free of roots or other woody vegetation, organic material, large stones, and other objectionable material. The embankment should be compacted in 6-inch layers by traversing with construction equipment.

MINIMUM TOP WIDTH (W) REQUIRED FOR SEDIMENT TRAP EMBANKMENTS ACCORDING TO HEIGHT OF EMBANKMENT (FEET)



H	H_O	W
1.5	0.5	2.0
2.0	1.0	2.0
2.5	1.5	2.5
3.0	2.0	2.5
3.5	2.5	3.0
4.0	3.0	3.0
4.5	3.5	4.0
5.0	4.0	4.5

Source: Va. DSWC Plate 3.13-1

3. The earthen embankment shall be seeded with temporary or permanent vegetation (see Std. & Spec.'s 3.31 and 3.32) immediately after installation.

4. Construction operations shall be carried out in such a manner that erosion and water pollution are minimized.

5. The structure shall be removed and the area stabilized when the upslope drainage area has been stabilized.

6. All cut and fill slopes shall be 2:1 or flatter (except for excavated, wet storage area which may be at a maximum 1:1 grade).

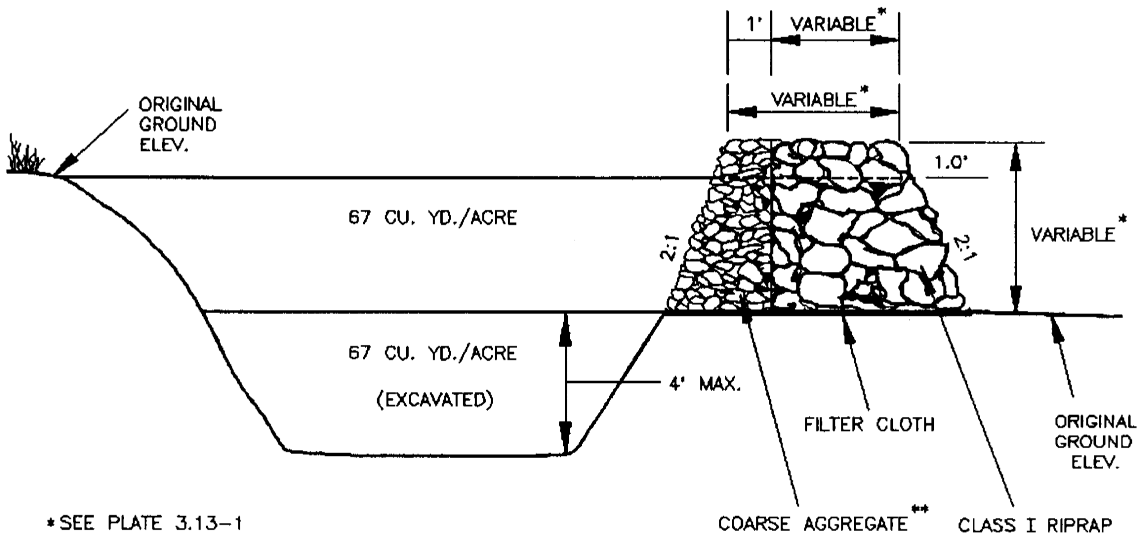
Maintenance

1. Sediment shall be removed and the trap restored to its original dimensions when the sediment has accumulated to one half the design volume of the wet storage. Sediment removal from the basin shall be deposited in a suitable area and in such a manner that it will not erode and cause sedimentation problems.

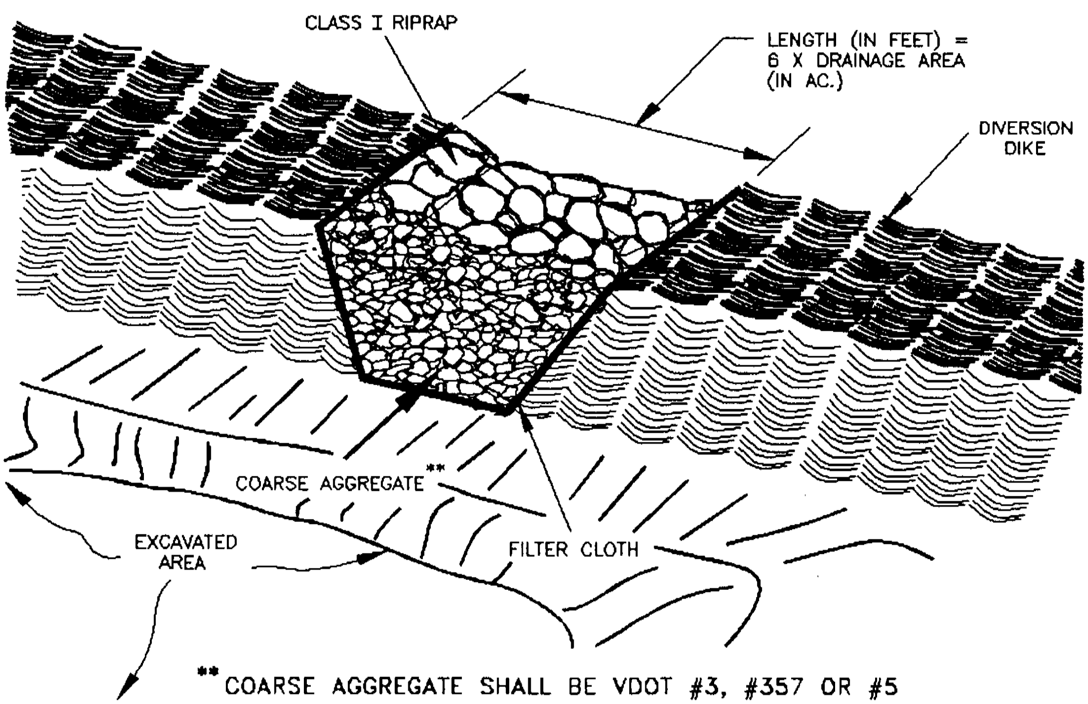
2. Filter stone shall be regularly checked to ensure that filtration performance is maintained. Stone choked with sediment shall be removed and cleaned or replaced.

3. The structure should be checked regularly to ensure that it is structurally sound and has not been damaged by erosion or construction equipment. The height of the stone outlet should be checked to ensure that its center is at least 1 foot below the top of the embankment.

TEMPORARY SEDIMENT TRAP



CROSS SECTION OF OUTLET



**COARSE AGGREGATE SHALL BE VDOT #3, #357 OR #5

OUTLET (PERSPECTIVE VIEW)

Source: Va. DSWC

Plate 3.13-2

STD & SPEC 3.18

OUTLET PROTECTION

OP

Definition

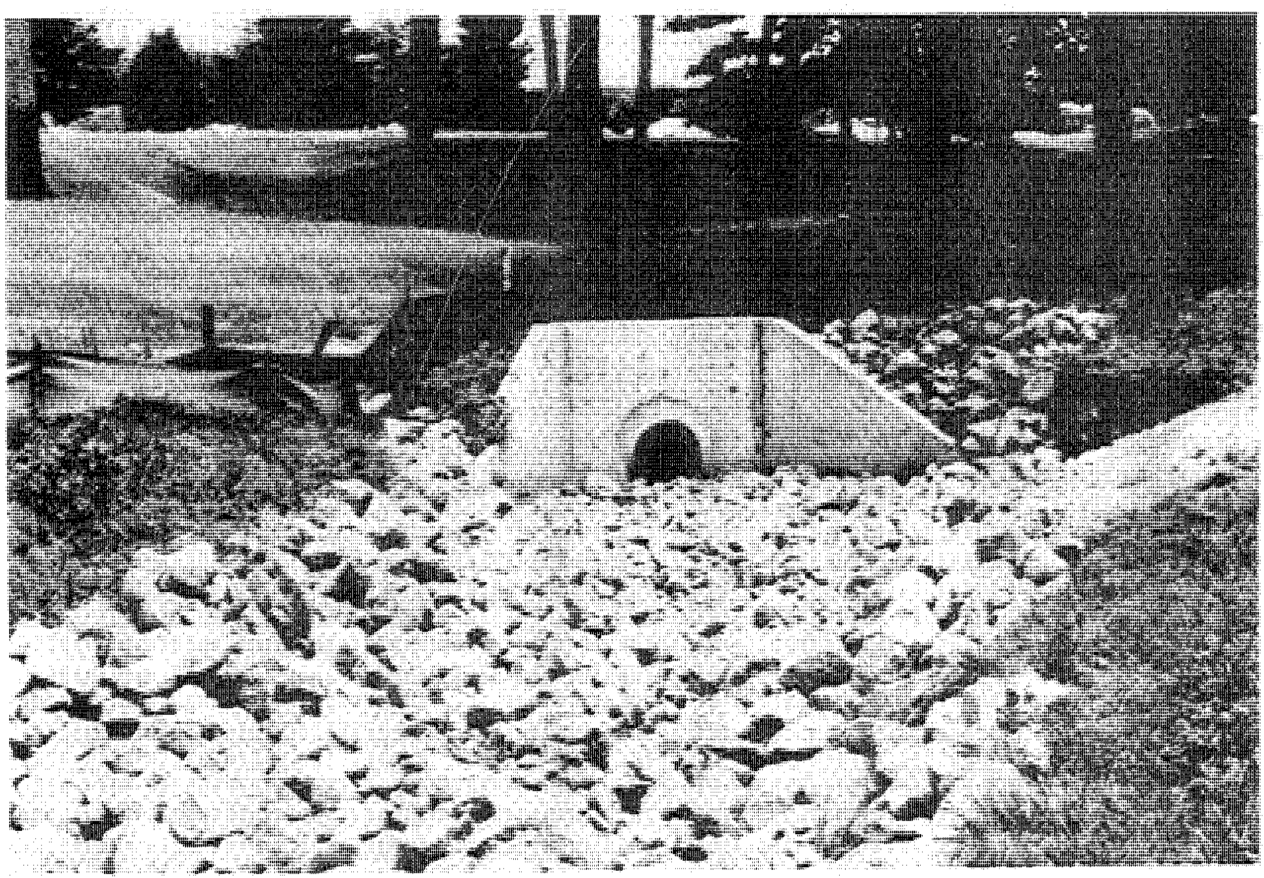
Structurally lined aprons or other acceptable energy dissipating devices placed at the outlets of pipes or paved channel sections.

Purpose

To prevent scour at stormwater outlets, to protect the outlet structure, and to minimize the potential for downstream erosion by reducing the velocity and energy of concentrated stormwater flows.

Conditions Where Practice Applies

Applicable to the outlets of all pipes and engineered channel sections.



Planning Considerations

The outlets of pipes and structurally lined channels are points of critical erosion potential. Stormwater which is transported through man-made conveyance systems at design capacity generally reaches a velocity which exceeds the capacity of the receiving channel or area to resist erosion. To prevent scour at stormwater outlets, a flow transition structure is needed which will absorb the initial impact of the flow and reduce the flow velocity to a level which will not erode the receiving channel or area.

The most commonly used device for outlet protection is a structurally lined apron. These aprons are generally lined with riprap, grouted riprap or concrete. They are constructed at a zero grade for a distance which is related to the outlet flow rate and the tailwater level. Criteria for designing such an apron are contained in this practice. Sample problems of outlet protection design are contained in Appendix 3.18-a.

Where flow is excessive for the economical use of an apron, excavated stilling basins may be used. Acceptable designs for stilling basins may be found in the following sources:

1. Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular No. 14, U. S. Department of Transportation, Federal Highway Administration (83).

2. Hydraulic Design of Stilling Basins and Energy Dissipators, Engineering Monograph No. 25, U.S. Department of the Interior - Bureau of Reclamation, (74).

   Note: Both of the above are available from the U.S. Government Printing Office.

Design Criteria

The design of structurally lined aprons at the outlets of pipes and paved channel sections applies to the immediate area or reach below the pipe or channel and does not apply to continuous rock linings of channels or streams (See STORMWATER CONVEYANCE CHANNEL, Std. & Spec. 3.17). Notably, pipe or channel outlets at the top of cut slopes or on slopes steeper than 10% should not be protected using just outlet protection as a result of the reconcentration and large velocity of flow encountered as the flow leaves the structural apron. Outlet protection shall be designed according to the following criteria:

Pipe Outlets

(See Plate 3.18-1)

1. Tailwater depth: The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. Manning's Equation may be used to determine tailwater depth (see Chapter 5, Engineering Calculations). If the tailwater depth is less than half the diameter of the outlet pipe, it shall be classified as a

Minimum Tailwater Condition. If the tailwater depth is greater than half the pipe diameter, it shall be classified as a Maximum Tailwater Condition. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition. Notably, in most cases where post-development stormwater runoff has been concentrated or increased, MS #19 will be satisfied only by outfall into a defined channel.

2. Apron length: The apron length shall be determined from the curves according to the tailwater condition:

   Minimum Tailwater - Use Plate 3.18-3.
   Maximum Tailwater - Use Plate 3.18-4.

3. Apron width: When the pipe discharges directly into a well-defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank (whichever is less).

   If the pipe discharges onto a flat area with no defined channel, the width of the apron shall be determined as follows:

   a. The upstream end of the apron, adjacent to the pipe, shall have a width three times the diameter of the outlet pipe.

   b. For a Minimum Tailwater Condition, the downstream end of the apron shall have a width equal to the pipe diameter plus the length of the apron.

   c. For a Maximum Tailwater Condition, the downstream end shall have a width equal to the pipe diameter plus 0.4 times the length of the apron.

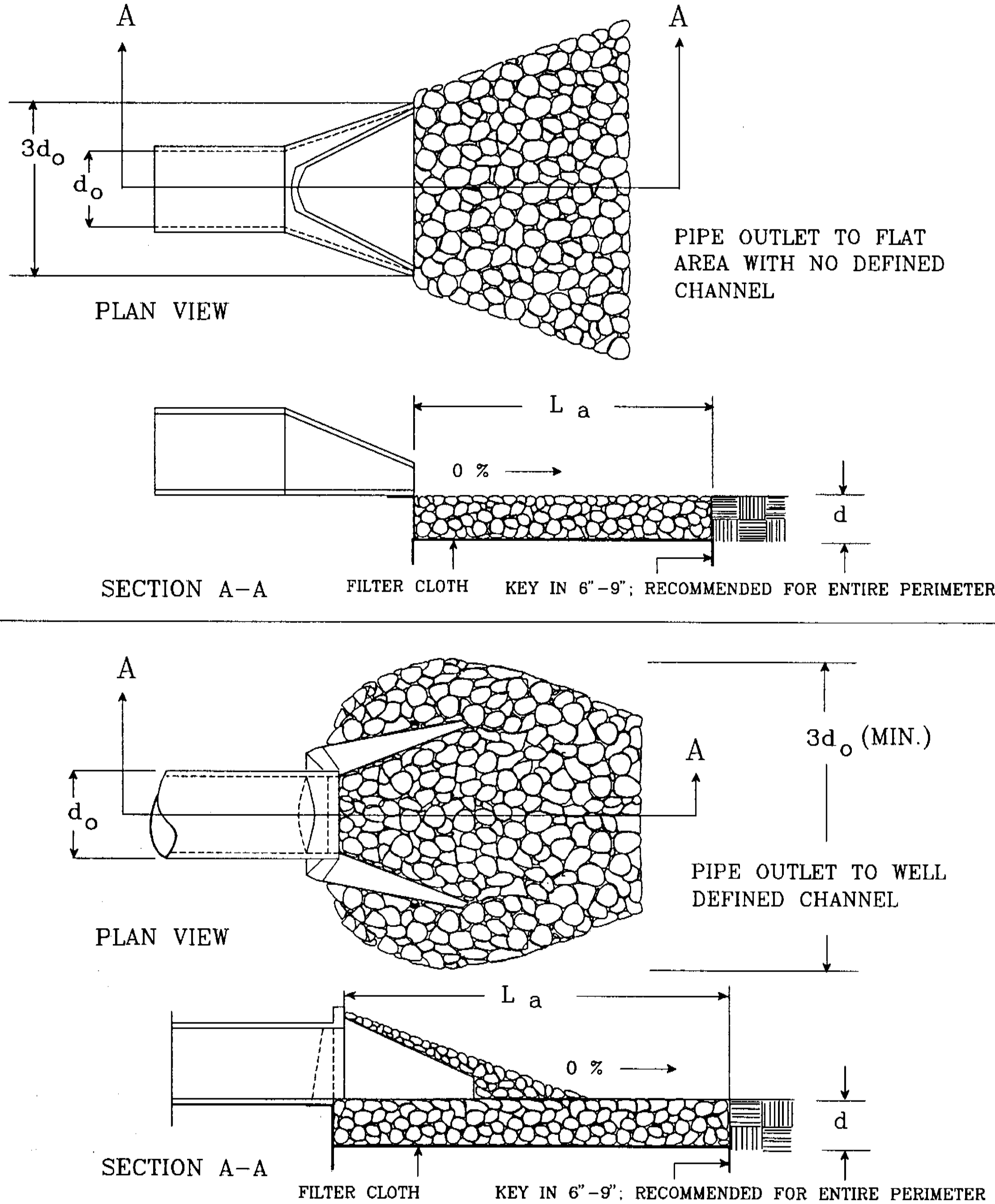
4. Bottom grade: The apron shall be constructed with no slope along its length (0.0% grade). The invert elevation of the downstream end of the apron shall be equal to the elevation of the invert of the receiving channel. There shall be no overfall at the end of the apron.

5. Side slopes: If the pipe discharges into a well-defined channel, the side slopes of the channel shall not be steeper than 2:1 (horizontal: vertical).

6. Alignment: The apron shall be located so there are not bends in the horizontal alignment.

7. Materials: The apron may be lined with riprap, grouted riprap, concrete, or gabion baskets. The median sized stone for riprap shall be determined from the curves in Appendix 3.18-a (Plates 3.18-3 and 3.18-4) according to the tailwater condition. The gradation, quality and placement of riprap shall conform to Std. & Spec. 3.19, RIPRAP.

PIPE OUTLET CONDITIONS



NOTES:
1. APRON LINING MAY BE RIPRAP, GROUTED RIPRAP, GABION BASKET, OR CONCRETE.
2. La IS THE LENGTH OF THE RIPRAP APRON AS CALCULATED USING PLATES 3.18-3 AND 3.18-4.
3. d = 1.5 TIMES THE MAXIMUM STONE DIAMETER, BUT NOT LESS THAN 6 INCHES.

Source: Va. DSWC

Plate 3.18-1

8. Filter cloth: In all cases, filter cloth shall be placed between the riprap and the underlying soil to prevent soil movement into and through the riprap. The material must meet or exceed the physical properties for filter cloth found in Std. & Spec. 3.19, RIPRAP. See Plate 3.18-1 for orientation details.

Paved Channel Outlets

(See Plate 3.18-2)

1. The flow velocity at the outlet of paved channels flowing at design capacity must not exceed the permissible velocity of the receiving channel (see Tables 3.18-A and 3.18-B)

2. The end of the paved channel shall merge smoothly with the receiving channel section. There shall be no overfall at the end of the paved section. Where the bottom width of the paved channel is narrower than the bottom width of the receiving channel, a transition section shall be provided The maximum side divergence of the transition shall be 1 in 3F where;

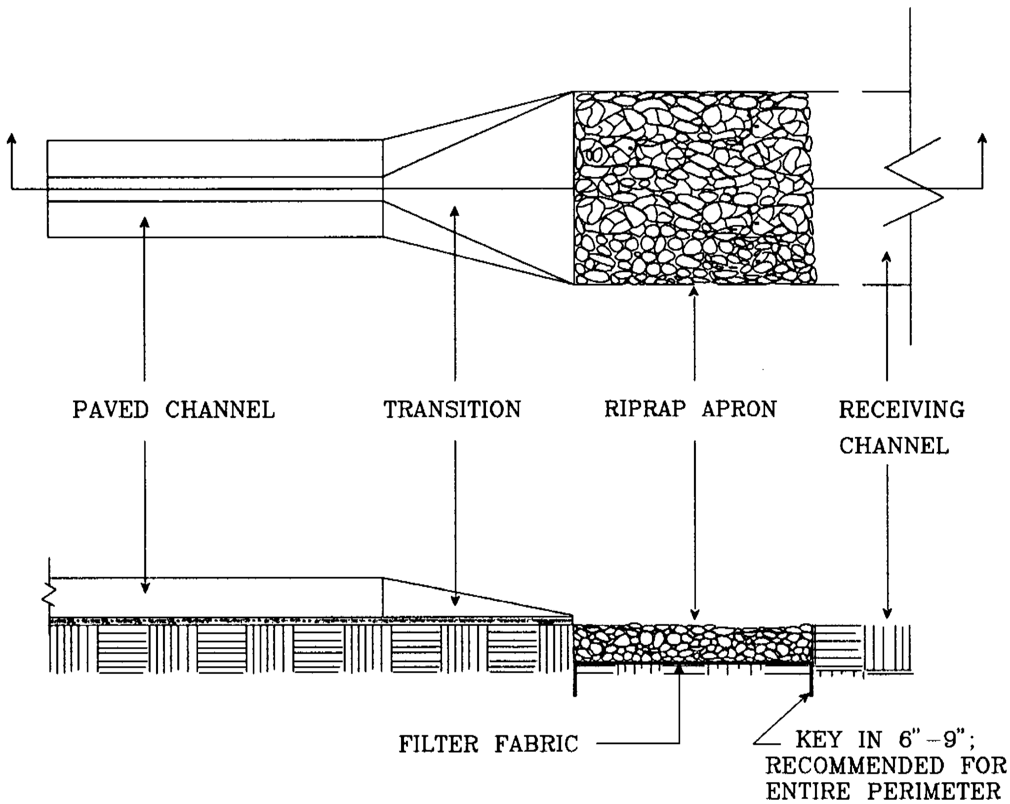
$$F = \frac{V}{\sqrt{gd}}$$

where,

F	=	Froude number
V	=	Velocity at beginning of transition (ft./sec.)
d	=	depth of flow at beginning of transition (ft.)
g	=	32.2 ft./sec.^{2}

3. Bends or curves in the horizontal alignment at the transition are not allowed unless the Froude number (F) is 1.0 or less, or the section is specifically designed for turbulent flow.

PAVED CHANNEL OUTLET



<u>NOTES:</u>

1. RIPRAP APRON REDUCES THE FLOW VELOCITY BELOW THE PERMISSIBLE VELOCITY OF THE NATURAL RECEIVING CHANNEL.
2. TRANSITION SIDE DIVERGENCE IS 1 IN 3F, WHERE

$$F = \text{FROUDE NUMBER} = \frac{V}{\sqrt{gd}}\text{, WHERE}$$

V = VELOCITY AT THE BEGINING OF THE TRANSITION
d = DEPTH OF FLOW AT THE BEGINING OF THE TRANSITION

$g = 32.2\ \text{ft./sec}^2$

Source: Va. DSWC

Plate 3.18-2

TABLE 3.18-A

PERMISSIBLE VELOCITIES FOR GRASS-LINED CHANNELS

Channel Slope	Lining	Velocity* (ft./sec.)
0 - 0.5%	Bermudagrass	6
	Reed canarygrass Tall fescue Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue Redtop Sericea lespedeza Annual lespedeza Small grains Temporary vegetation	2.5
5 - 10%	Bermudagrass	5
	Reed canarygrass Tall fescue Kentucky bluegrass	4
	Grass-legume mixture	3
Greater than 10%	Bermudagrass	4
	Reed canarygrass Tall fescue Kentucky bluegrass	3

* For highly erodible soils, decrease permissible velocities by 25%.

Source: Soil and Water Conservation Engineering, Schwab, et. al. and American Society of Civil Engineers

TABLE 3.18-B?

PERMISSIBLE VELOCITIES FOR EARTH LININGS

Soil Types	Permissible Velocities (ft./sec.)
Fine Sand (noncolloidal)	2.5
Sandy Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (colloidal)	5.5
Alluvial Silts (noncolloidal)	5.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5
Shales and Hard Plans	6.0

Source: Soil and Water Conservation Engineering, Schwab, et.al. and American Society of Civil Engineers

APPENDIX 3.18-a

Sample Problems: Outlet Protection Design

Example 1

Given: An 18-inch pipe discharges 24 cfs at design capacity onto a grassy slope (no defined channel).

Find: The required length, width and median stone size (d_{50}) for a riprap-lined apron.

Solution:

1. Since the pipe discharges onto a grassy slope with no defined channel, a Minimum Tailwater Condition may be assumed.

2. From Plate 3.18-3, an apron length (L_a) of 20 feet and a median stone size (d_{50}) of 0.8 ft. are determined.

3. The upstream apron width equals three times the pipe diameter; 3 x 1.5 ft = 4.5 ft.

4. The downstream apron width equals the apron length plus the pipe diameter; 20 ft. + 1.5 ft. = 21.5 ft.

Example 2

Given: The pipe in example No. 1 discharges into a channel with a triangular cross-section, 2 feet deep and 2:1 side slopes. The channel has a 2% slope and an "n" factor of .045.

Find: The required length, width and the median stone size (d_{50}) for a riprap lining.

Solution:

1. Determine the tailwater depth using Manning's Equation.

$$Q = \frac{1.49}{n} R^{\frac{2}{3}} S^{\frac{1}{2}} A$$

$$24 = \frac{1.49}{.045}\left(\frac{2d}{2\sqrt{2^2+1}}\right)^{\frac{2}{3}}(.02)^{\frac{1}{2}}(2d^2)$$

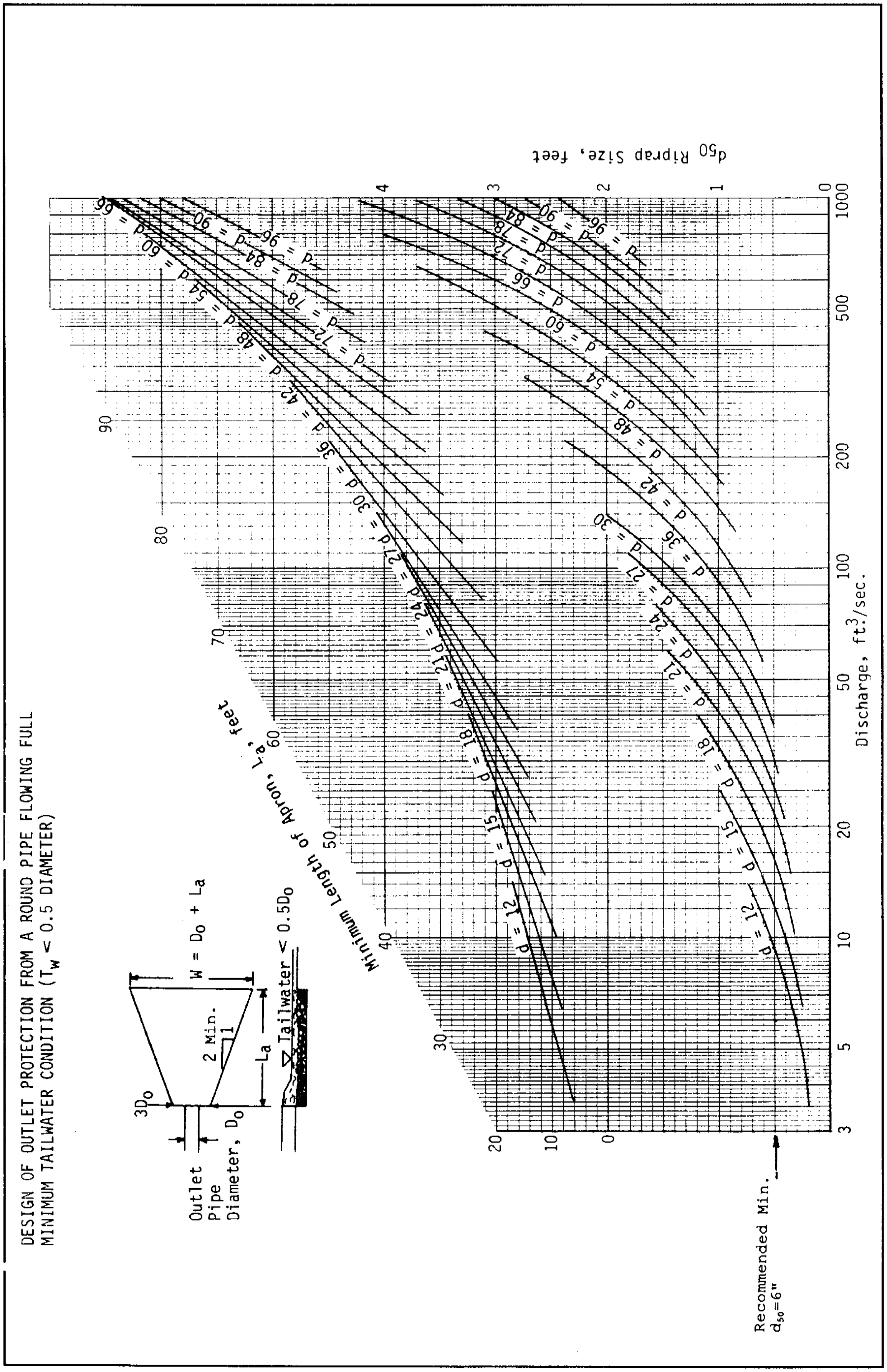
where,

d = depth of tailwater
d = 1.74 ft. *

* since d is greater than half the pipe diameter, a Maximum Tailwater Condition exists.

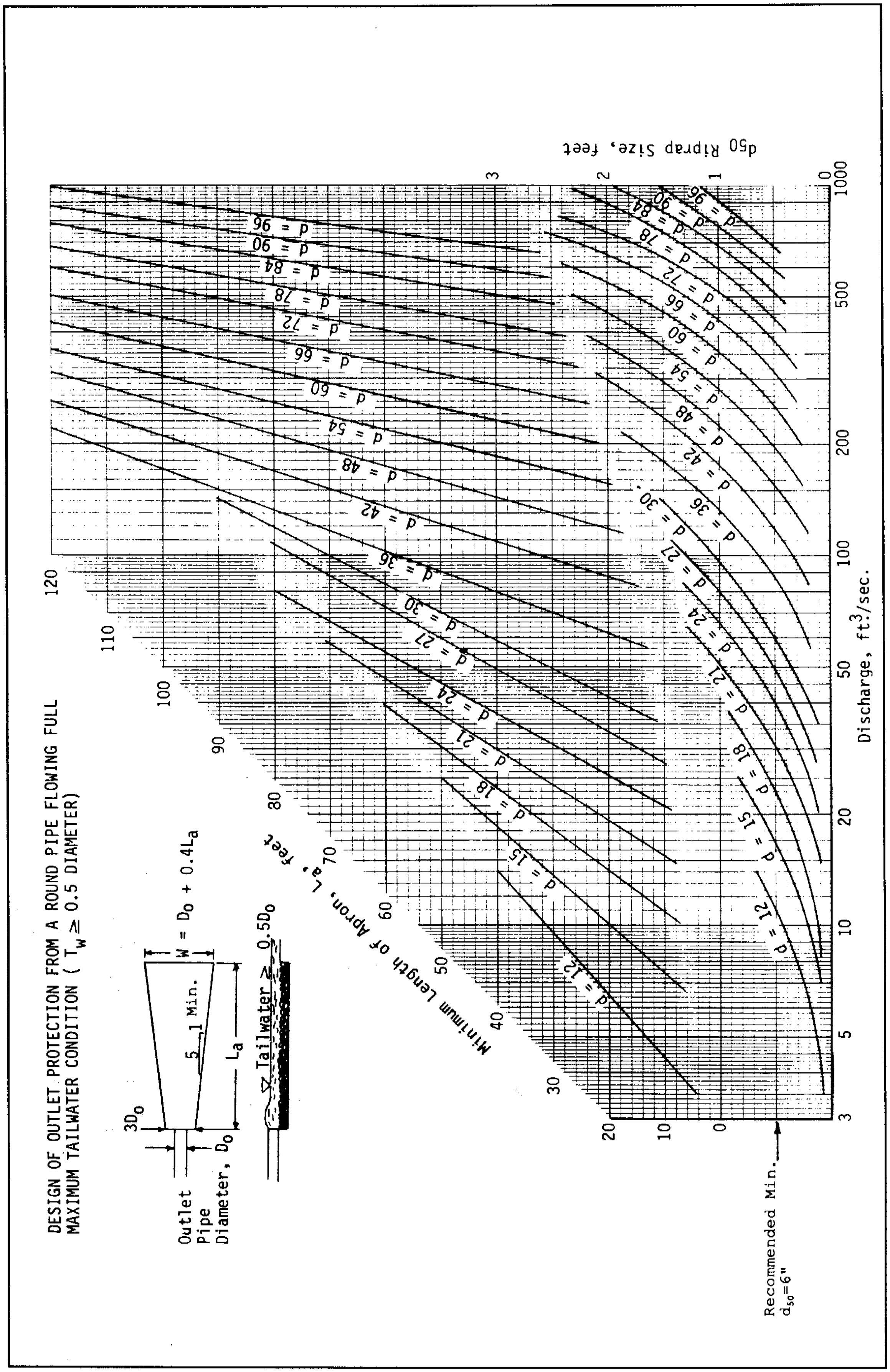
2. From Plate 3.18-4, a median stone size (d_{50}) of 0.5 ft. and an apron length (L_a) of 41 ft. is determined.

3. The entire channel cross-section should be lined since the maximum tailwater depth is within one foot of the top of the channel.



Source: USDA-SCS

Plate 3.18-3



Source: USDA-SCS

Plate 3.18-4

STD & SPEC 3.19

RIPRAP

RR

Definition

A permanent, erosion-resistant ground cover of large, loose, angular stone with filter fabric or granular underlining.

Purposes

1. To protect the soil from the erosive forces of concentrated runoff.

2. To slow the velocity of concentrated runoff while enhancing the potential for infiltration.

3. To stabilize slopes with seepage problems and/or non-cohesive soils.

Conditions Where Practice Applies

Wherever soil and water interface and the soil conditions, water turbulence and velocity, expected vegetative cover, etc., are such that the soil may erode under the design flow conditions. Riprap may be used, as appropriate, at stormdrain outlets, on channel banks and/or bottoms, roadside ditches, drop structures, at the toe of slopes, as transition from concrete channels to vegetated channels, etc.

Planning Considerations

Graded vs. Uniform Riprap

Riprap is classified as either graded or uniform. A sample of graded riprap would contain a mixture of stones which vary in size from small to large. A sample of uniform riprap would contain stones which are all fairly close in size.

For most applications, graded riprap is preferred to uniform riprap. Graded riprap forms a flexible self-healing cover, while uniform riprap is more rigid and cannot withstand movement of the stones. Graded riprap is cheaper to install, requiring only that the stones be dumped so that they remain in a well-graded mass. Hand or mechanical placement of individual stones is limited to that necessary to achieve the proper thickness and line. Uniform riprap requires placement in a more or less uniform pattern, requiring more hand or mechanical labor.

Riprap sizes can be designed by either the diameter or the weight of the stones. It is often misleading to think of riprap in terms of diameter, since the stones should be angular instead of spherical. However, it is simpler to specify the diameter of an equivalent size of spherical stone. Table 3.19-A lists some typical stones by weight, spherical diameter and the corresponding rectangular dimensions. These stone sizes are based upon an assumed specific weight of 165 lbs./ft^3.

Since graded riprap consists of a variety of stone sizes, a method is needed to specify the size range of the mixture of stone. This is done by specifying a diameter of stone in the mixture for which some percentage, by weight, will be smaller. For example, d_{85} refers to a mixture of stones in which 85% of the stone by weight would be smaller than the diameter specified. Most designs are based on d_{50}. In other words, the design is based on the average size of stone in the mixture. Table 3.19-B lists VDOT standard graded riprap sizes by diameter the weight of the stone.

To ensure that stone of substantial weight is used when implementing riprap structures, specified weight ranges for individual stones and composition requirements should be followed. Such guidelines will help to prevent inadequate stone from being used in construction of the measures and will promote more consistent stone classification statewide. Table 3.19-C notes these requirements.

TABLE 3.19-A

SIZE OF RIPRAP STONES

Weight (lbs.)	Mean Spherical Diameter (ft.)	Angular Shape: Length (ft.)	Width, Height (ft.)
50	0.8	1.4	0.5
100	1.1	1.75	0.6
150	1.3	2.0	0.67
300	1.6	2.6	0.9
500	1.9	3.0	1.0
1,000	2.2	3.7	1.25
1,500	2.6	4.7	1.5
2,000	2.75	5.4	1.8
4,000	3.6	6.0	2.0
6,000	4.0	6.9	2.3
8,000	4.5	7.6	2.5
20,000	6.1	10.0	3.3

Source: VDOT Drainage Manual

Sequence of Construction

Since riprap is used where erosion potential is high, construction must be sequenced so that the riprap is put in place with the minimum possible delay. Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance. Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.

Design Criteria

Gradation

The riprap shall be composed of a well-graded mixture down to the one-inch size particle such that 50% of the mixture by weight shall be larger than the d_{50} size as determined from the design procedure. A well-graded mixture as used herein is defined as a mixture composed primarily of the larger stone sizes but with a sufficient mixture of other sizes to fill the progressively smaller voids between the stones. The diameter of the largest stone size in such a mixture shall be 1½ times the d_{50} size.

TABLE 3.19-B

GRADED RIPRAP - DESIGN VALUES

Riprap Class	D_{15} Weight (lbs.)	Mean D_{15} Spherical Diameter (ft.)	Mean D_{50} Spherical Diameter (ft.)
Class AI	25	0.7	0.9
Class I	50	0.8	1.1
Class II	150	1.3	1.6
Class III	500	1.9	2.2
Type I	1,500	2.6	2.8
Type II	6,000	4.0	4.5

Source: VDOT Drainage Manual

The designer, after determining the riprap size that will be stable under the flow conditions, shall consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size. The possibility of damage by children shall be considered in selecting a riprap size, especially if there is nearby water or a gully in which to toss the stones.

Thickness

The minimum thickness of the riprap layer shall be 2 times the maximum stone diameter, but not less than 6 inches.

Quality of Stone

Stone for riprap shall consist of field stone or rough unhewn quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all respects for the purpose intended. The specific gravity of the individual stones shall be at least 2.5.

Rubble concrete may be used provided it has a density of at least 150 pounds per cubic foot, and otherwise meets the requirement of this standard and specification.

TABLE 3.19-C

GRADED RIPRAP - WEIGHT ANALYSIS

Riprap Class/Type	Weight Range* (lbs.)	Requirements for Stone Mixture
Class AI	25-75	Max. 10% > 75 lbs.
Class I	50-150	60% > 100 lbs.
Class II	150-500	50% > 300 lbs.
Class III	500-1,500	50% > 900 lbs.
Type I	1,500-4,000	Av. wt. = 2,000 lbs.
Type II	6,000-20,000	Av. wt. = 8,000 lbs.

* In all classes/types of riprap, a maximum 10% of the stone in the mixture may weigh less than the lower end of the range.

Source: Adapted from VDOT Road and Bridge Specifications

Filter Fabric Underlining

A lining of engineering filter fabric (geotextile) shall be placed between the riprap and the underlying soil surface to prevent soil movement into or through the riprap. Table 3.19-D notes the minimum physical properties of the filter fabric.

Filter fabric shall not be used on slopes greater than 1½:1 as slippage may occur and should be used in conjunction with a layer of course aggregate (granular filter blanket is described below) when the riprap to be placed is Class II or larger.

Granular Filter

Although the filter cloth underlining or bedding is the preferred method of installation, a granular (stone) bedding is a viable option when the following relationship exists:

$$\frac{d_{15}\ filter}{d_{85}\ base} < 5 < \frac{d_{15}\ filter}{d_{15}\ base} < 40$$

and,

$$\frac{d_{50}\ filter}{d_{50}\ base} < 40$$

In these relationships, filter refers to the overlying material and base refers to the underlying material. The relationships must hold between the filter material and the base material and between the riprap and the filter material. In some cases, more than one layer of filter material may be needed. Each layer of filter material should be approximately 6-inches thick.

TABLE 3.19-D

REQUIREMENTS FOR FILTER FABRIC USED WITH RIPRAP

Physical Property	Test Method	Requirements
Equivalent Opening Size	Corps of Engineers CWO 2215-77	Equal or greater than U.S. No. 50 sieve
Tensile Strength* @ 20% (maximum)	VTM-52	30 lbs./linear in. (minimum)
Puncture Strength	ASTM D751*	80 lbs. (minimum)

* Tension testing machine with ring clamp, steel ball replaced with 5/16 diameter solid steel cylinder with hemispherical tip centered within the ring clamp.

Seams shall be equal in strength to basic material.

Additional fabric material or non-corrosive steel wire may be incorporated into the fabric to increase overall strength.

Source: VDOT Road and Bridge Specifications

Riprap at Outlets

Design criteria for sizing the stone and determining the dimensions of riprap pads used at the outlet of drainage structure are contained in OUTLET PROTECTION (Std. & Spec. 3.18). A filter fabric underlining is required for riprap used as outlet protection.

Riprap for Channel Stabilization

Riprap for channel stabilization shall be designed to be stable for the condition of bank-full flow in the reach of channel being stabilized. The design procedure in Appendix 3.19-a, which is extracted from the Federal Highway Administration's Design of Stable Channels with Flexible Linings (82), shall be used. This method establishes the stability of the rock material relative to the forces exerted upon it.

Riprap shall extend up the banks of the channel to a height equal to the maximum depth of flow or to a point where vegetation can be established to adequately protect the channel.

The riprap size to be used in a channel bend shall extend upstream from the point of curvature and downstream from the bottom of the channel to a minimum depth equal to the thickness of the blanket and shall extend across the bottom of the channel the same distance (see Plate 3.19-1).

Freeboard and Height of Bank

For riprapped and other lined channels, the height of channel lining above the water surface should be based on the size of the channel, the flow velocity, the curvature, inflows, wind action, flow regulation, etc.

The height of the bank above the water surface varies in a similar manner, depending on the above factors plus the type of soil.

Plate 3.19-2 is based on information developed by the U.S. Bureau of Reclamation for average freeboard and bank height in relation to channel capacity. This chart should be used by the designer to obtain a minimum freeboard for placement of riprap and top of bank.

Riprap for Slope Stabilization

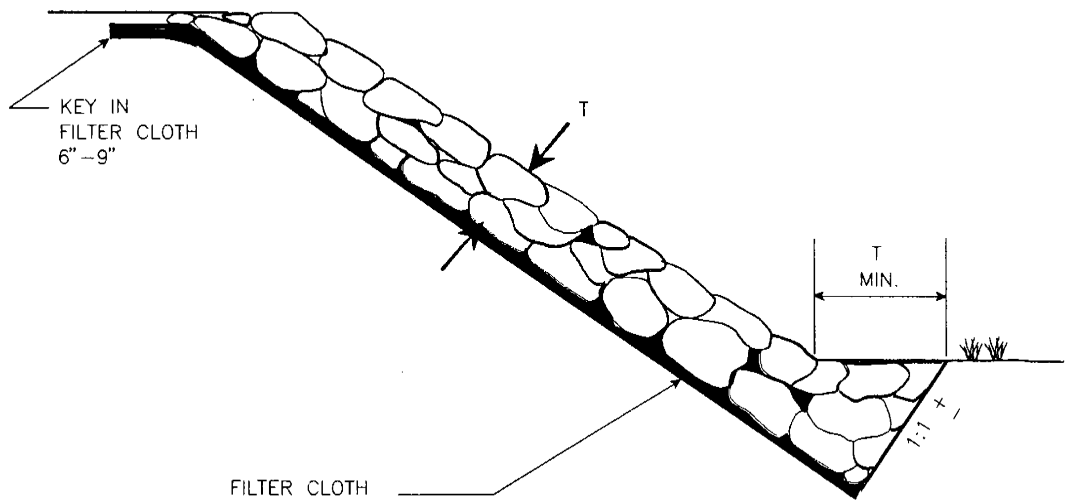
Riprap for slope stabilization shall be designed so that the natural angle of repose of the stone mixture is greater than the gradient of the slope being stabilized (see Plate 3.19-5).

Riprap for Lakes and Ponds Subject to Wave Action

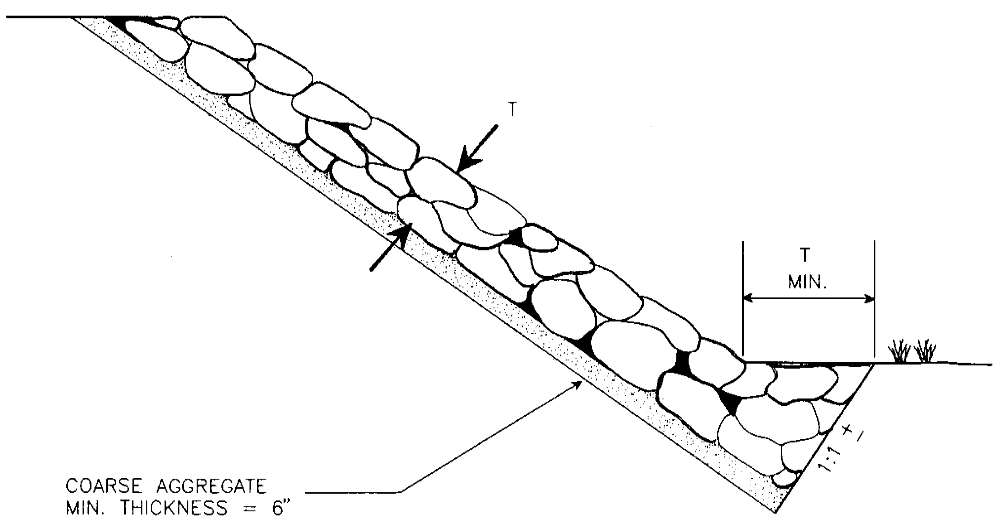
Riprap used for shoreline protection on lakes and ponds may be subject to wave action. The waves affecting the shoreline may be wind-driven or created by boat wakes. Consult

TOE REQUIREMENTS FOR BANK STABILIZATION

FILTER CLOTH UNDERLINER (PREFERRED)



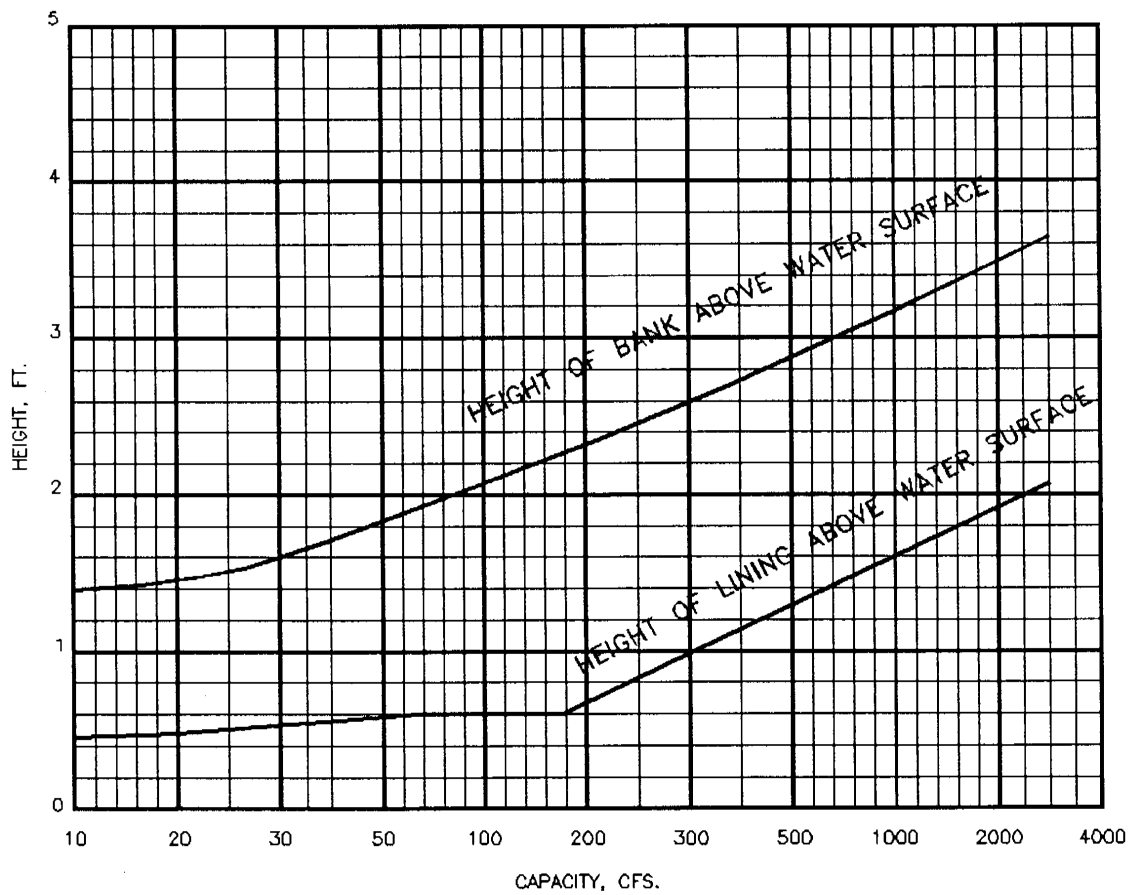
GRANULAR FILTER



Source: Adapted from VDOT Drainage Manual

Plate 3.19-1

RECOMMENDED FREEBOARD AND HEIGHT OF BANK OF LINED CHANNELS



Source: U. S. Bureau of Reclamation

Plate 3.19-2

the latest edition of the VDOT Drainage Manual ("Design of Slope Protection to Resist Wave Action") for specific design criteria in determining the required size of stones and the design wave height for such an installation. Use the equations in Appendix 3.19-b to calculate other pertinent design parameters. For more in-depth design criteria concerning these installations, see the U.S. Army Corps of Engineers' Shore Protection Manual (59).

Riprap for Abrupt Channel Contractions

Refer to latest edition of VDOT Drainage Manual.

Riprap for Installations Subject to Tidal and Wave Action

The design of riprap structures for tidal areas is beyond the scope of the VESCL and VESCR. The DSWC's Shoreline Programs Bureau provides advice regarding minimum design parameters for these installations. Notably, a riprap design for shoreline protection in tidal areas must meet all applicable state and federal requirements and should be carried out by a qualified professional.

Construction Specifications

Subgrade Preparation: The subgrade for the riprap or filter shall be prepared to the required lines and grades. Any fill required in the subgrade shall be compacted to a density approximately that of the surrounding undisturbed material. Brush, trees, stumps and other objectionable material shall be removed.

Filter Fabric or Granular Filter: Placement of the filter fabric should be done immediately after slope preparation. For granular filters, the stone should be spread in a uniform layer to the specified depth (normally 6 inches). Where more than one layer of filter material is used, the layer should be spread so that there is minimal mixing of the layers.

When installing geotextile filter cloths, the cloth should be placed directly on the prepared slope. The edges of the sheets should overlap by at least 12 inches. Anchor pins, 15 inches long, should be spaced every 3 feet along the overlap. The upper and lower ends of the cloth should be buried at least 12 inches. Care should be taken not to damage the cloth when placing the riprap. If damage occurs, that sheet should be removed and replaced. For large stone (Class II or greater), a 6-inch layer of granular filter will be necessary to prevent damage to the cloth.

Stone Placement: Placement of riprap should follow immediately after placement of the filter. The riprap should be placed so that it produces a dense well-graded mass of stone with a minimum of voids. The desired distribution of stones throughout the mass may be obtained by selective loading at the quarry, controlled dumping of successive loads during final placing, or by a combination of these methods. The riprap should be placed to its full thickness in one operation. The riprap should not be placed in layers. The riprap should not be placed by dumping into chutes or similar methods which are likely to cause segregation of the various stone sizes. Care should be taken not to dislodge the underlying material when placing the stones.

The finished slope should be free of pockets of small stone or clusters of large stones. Hand placing may be necessary to achieve the required grades and a good distribution of stone sizes. Final thickness of the riprap blanket should be within plus or minus 1/4 of the specified thickness.

Maintenance

Once a riprap installation has been completed, it should require very little maintenance. It should, however, be inspected periodically to determine if high flows have caused scour beneath the riprap or filter fabric or dislodged any of the stone. Care must be taken to properly control sediment-laden construction runoff which may drain to the point of the new installation. If repairs are needed, they should be accomplished immediately.

APPENDIX 3.19-a

RIPRAP DESIGN IN CHANNEL

The design method described below is adapted from Hydraulic Engineering Circular No. 15 of the Federal Highway Administration. It is applicable to both straight and curved sections of channel where the flow is tangent to the bank of the channel.

Tangent Flow - Federal Highway Administration Method

This design method determines a stable rock size for straight and curved sections of channels. It is assumed that the shape, depth of flow, and slope of the channel are known. A stone size is chosen for the maximum depth of flow. If the sides of the channel are steeper than 3:1, the stone size must be modified accordingly. The final design size will be stable on both sides of the channel and the bottom.

1. Enter Plate 3.19-3 with the maximum depth of flow (feet) and channel slope (feet/foot). Where the two lines intersect, choose the d_{50} size of stone. (Select the d_{50} for the diagonal line above the point of intersection).

2. If channel side slopes are steeper than 3:1, continue with step 3; if not, the procedure is complete.

3. Enter Plate 3.19-4 with the side slope and the base width to maximum depth ratio (B/d). Where the two lines intersect, move horizontally left to read K_1.

4. Determine from Plate 3.19-5 the angle of repose for the d_{50} size of stone and the side slope of the channel. (Use 42° for d_{50} greater than 1.0. Do not use riprap on slopes steeper than the angle of repose for the size of stone).

5. Enter Plate 3.19-6 with the side slope of the channel and the angle of repose for the d_{50} size of stone. Where the two lines intersect, move vertically down to read k_2.

6. Compute $d_{50} \times K_1/K_2 = d'_{50}$ to determine the correct size stone for the bottom and side slopes of straight sections of channel.

For Curved Sections of Channel

1. Compute the radius of the curve (Ro), measured at the outside edge of the bottom.

2. Compute the ratio of the top width of the water surface (Bs) to the radius of the curve (Ro), Bs/Ro.

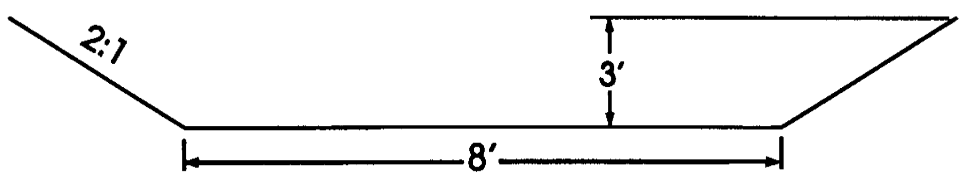
3. Enter Plate 3.19-7 with the radio Bs/Ro. Move vertically until the curve is intersected. Move horizontally left to read K_3.

4. Compute d'_{50} x K_3 = d_{50c} to determine the correct size stone for bottom and side slopes of the curved sections of channel.

Example Problem

Given:

A trapezoidal channel 3 feet deep, 8 foot bottom width, 2:1 side slopes, and a 2% slope.



Calculate:

A stable riprap size for the bottom and side slopes of the channel.

Solution:

1. From Plate 3.19-3, for a 3-foot-deep channel on a 2% grade, d_{50} = 0.75 feet or 9 inches.

2. Since the side slopes are steeper than 3:1, continue with step 3.

3. From Plate 3.19-4, B/d = 8/3 = 2.67, Z = 2, K_1 = 0.82.

4. From Plate 3.19-5, for d_{50} = 9 inches, = 41°.

5. From Plate 3.19-6, for Z = 2 and = 41°, K_2 = 0.73.

6. d_{50} x K_1/k_2 = d'_{50} = 0.75 x 0.82/0.73 = 0.84 feet.

$$0.84 \text{ feet} \times \frac{12 \text{ inches}}{1 \text{ foot}} = 10.08. \text{ Use } d'_{50} = 10 \text{ inches.}$$

Given:

The preceding channel has a curved section with a radius of 50 feet.

Calculate:

A stable riprap size for the bottom and side slopes of the curved section of channel.

Solution:

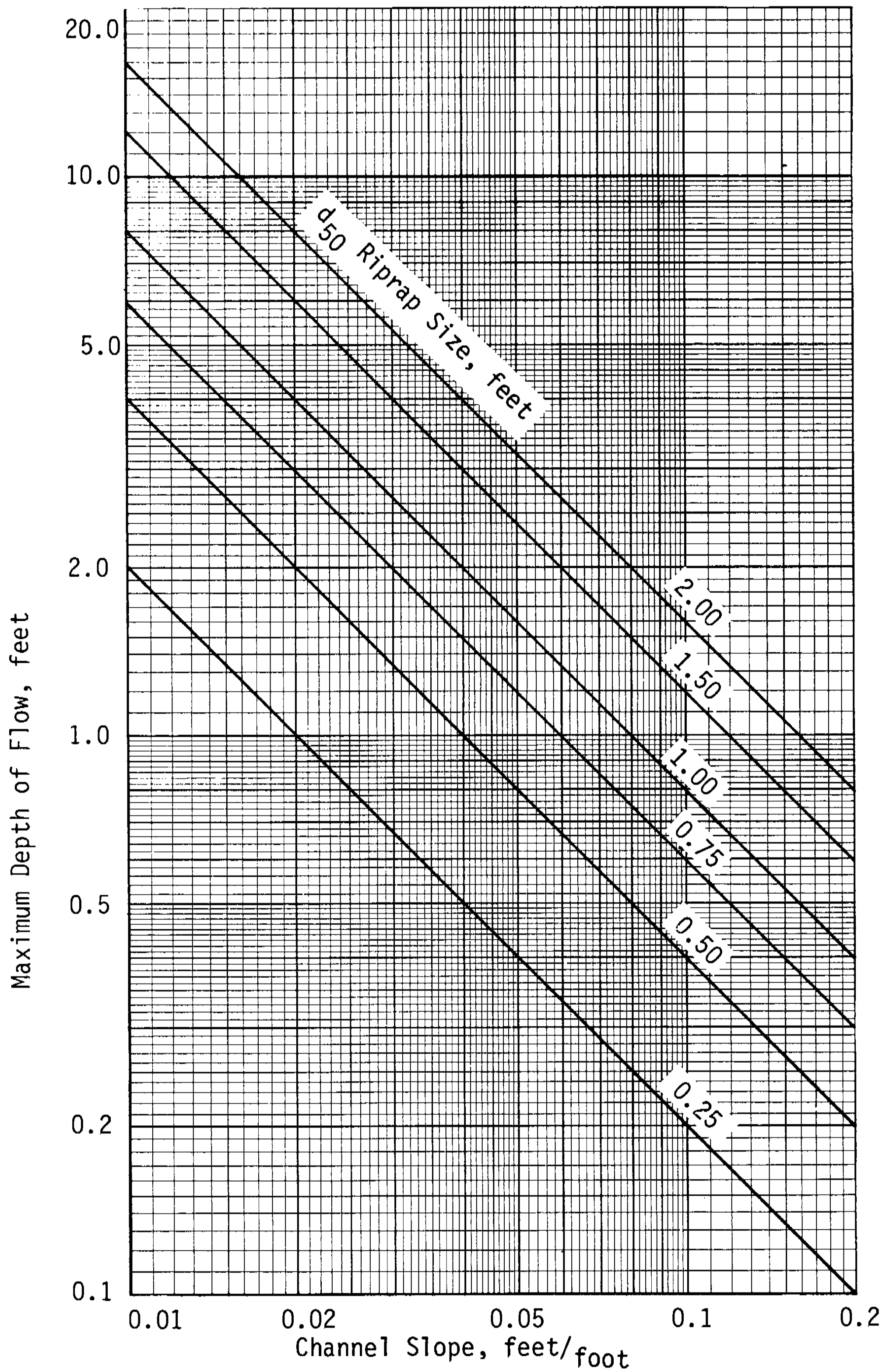
1. Ro = 50 feet

2. Bs/Ro = 20/50 = 0.40

3. From Plate 3.19-7, for Bs/Ro = 0.40, K_3 = 1.1

4. $d'_{50} \times K_3 = 0.84 \times 1.1 = 0.92$ feet

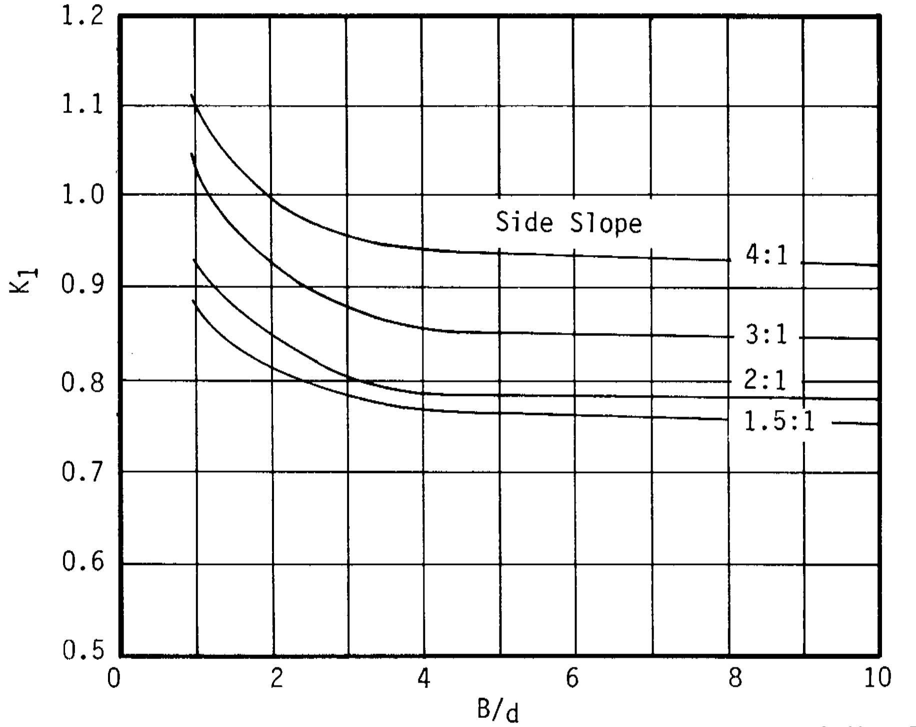
   $0.92 \text{ feet} \times \dfrac{12 \text{ inches}}{1 \text{ foot}} = 11.0.$



MAXIMUM DEPTH OF FLOW FOR RIPRAP LINED CHANNELS

Source: VDOT Drainage Manual

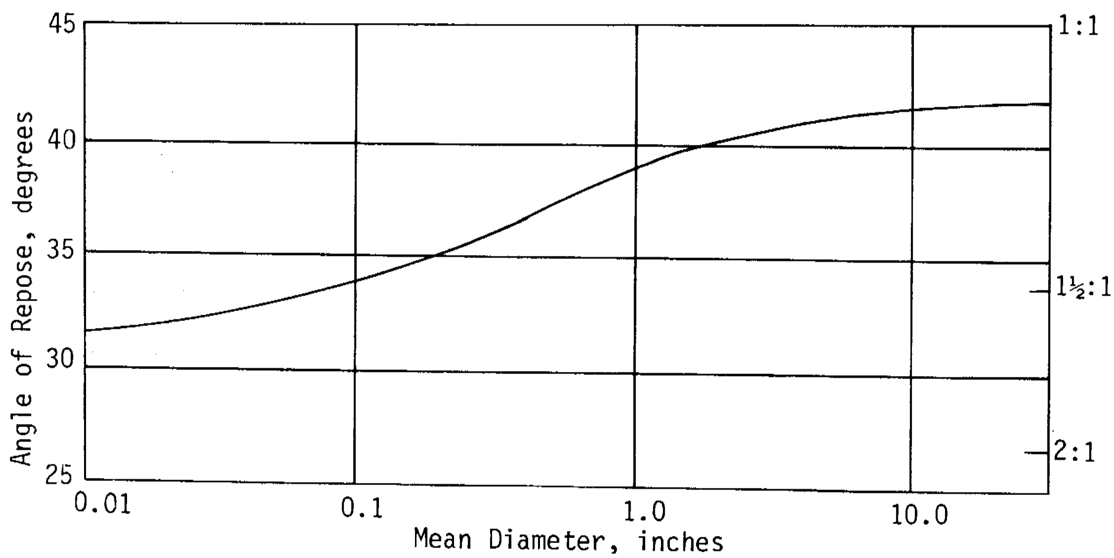
Plate 3.19-3



DISTRIBUTION OF BOUNDARY SHEAR AROUND WETTED PERIMETER OF TRAPEZOIDAL CHANNEL

Source: VDOT Drainage Manual

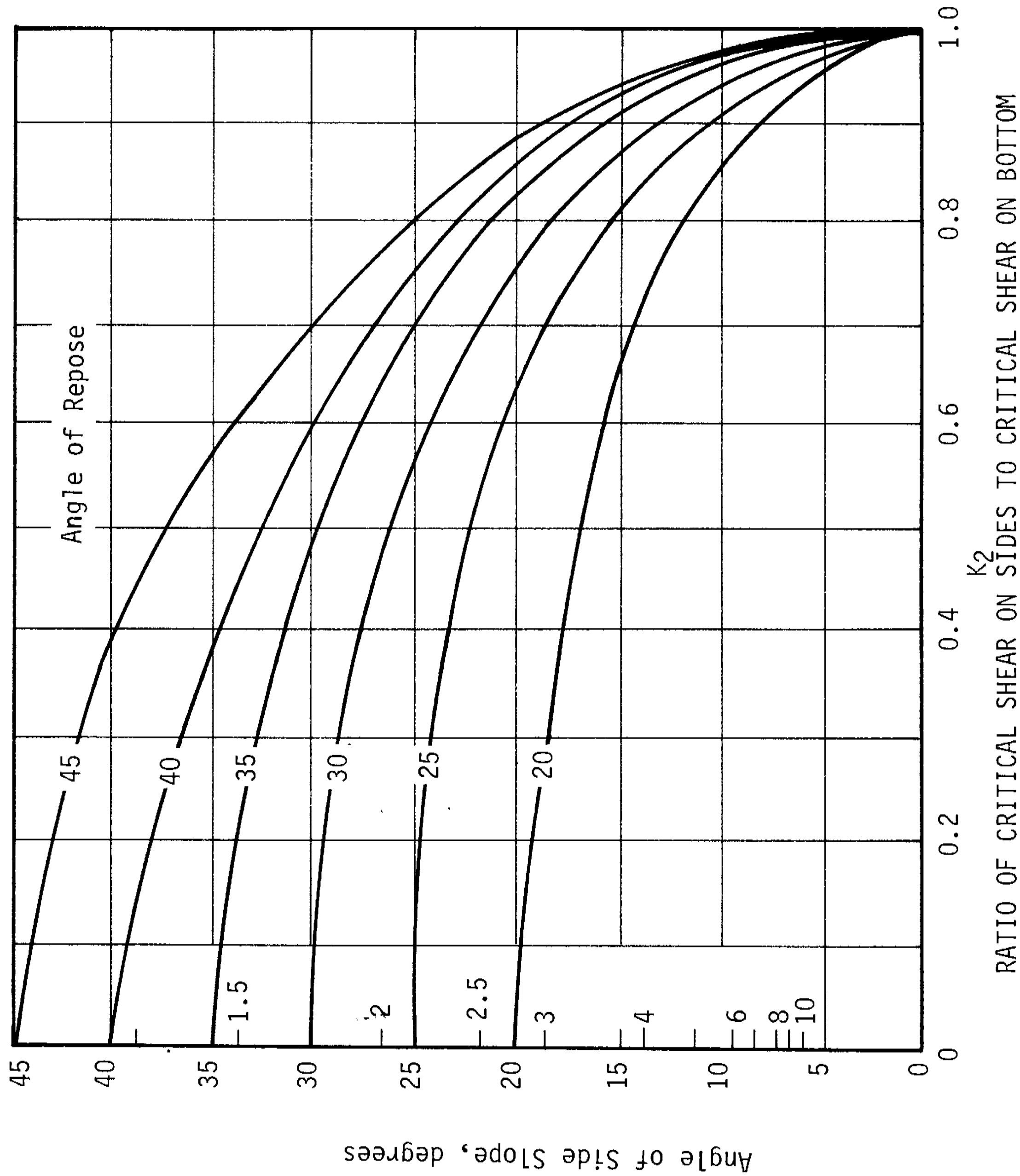
Plate 3.19-4



ANGLE OF REPOSE FOR RIPRAP STONES

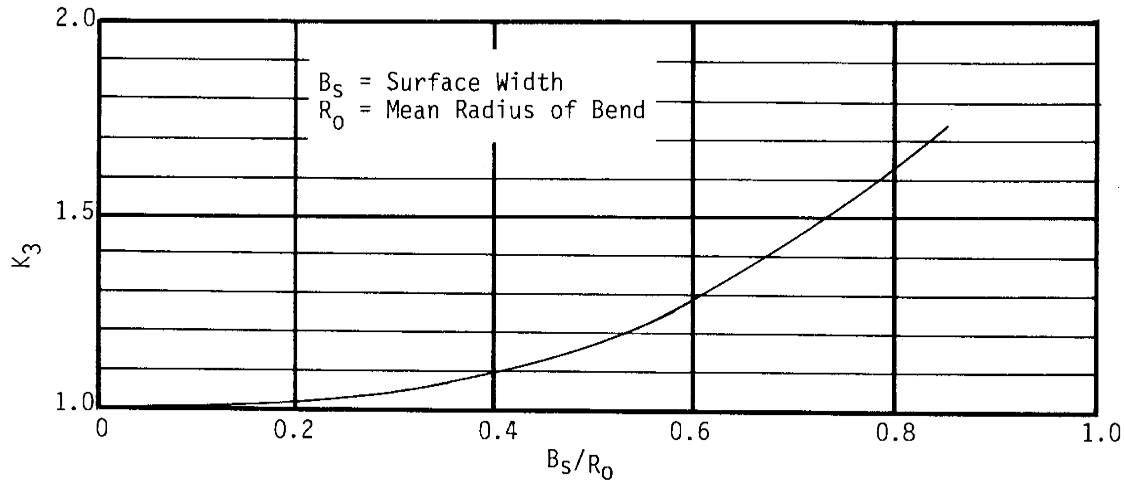
Source: VDOT Drainage Manual

Plate 3.19-5



Source: VDOT Drainage Manual

Plate 3.19-6



RATIO OF MAXIMUM BOUNDARY SHEAR IN BENDS TO MAXIMUM BOTTOM SHEAR IN STRAIGHT REACHES

Source: VDOT Drainage Manual

Plate 3.19-7

APPENDIX 3.19-b

RIPRAP DESIGN EQUATIONS FOR LAKES AND PONDS SUBJECT TO WAVE ACTION

In many instances, riprap is installed along the shoreline of nontidal ponds and lakes in order to protect them from the continual scour of wind-driven waves. The following methods/equations will produce minimum design parameters for size of stone, depth of buried toe (or width of riprap apron) and height of structure above average water level.

I. **Size of Riprap Required** - See VDOT Drainage Manual ("Design of Slope Protection to Resist Wave Action").

II. **DWH** (Design Wave Height) - See VDOT Drainage Manual ("Design of Slope Protection to Resist Wave Action") or U.S. Army Corps of Engineers' Shore Protection Manual.

III. **Depth of Buried Toe** = DWH at design wind speed.

IV. **Width of Riprap Apron** (Alternative to Buried Toe) = DWH x 2

V. **Height of Structure** (Above the Average Water Level) = DWH x 1.5

STD & SPEC 3.22

VEGETATIVE STREAMBANK STABILIZATION

VSS

Definition

The use of vegetation in stabilizing streambanks.

Purpose

To protect streambanks from the erosive forces of flowing water.

Conditions Where Practice Applies

Along banks in creeks, streams and rivers subject to erosion from excess runoff. This practice is generally applicable where bankfull flow velocity does not exceed 5 ft./sec. and soils are erosion resistant. Above 5 ft./sec., structural measures are generally required. This practice does not apply where tidal conditions exist.

Planning Considerations

A primary cause of stream channel erosion is the increased frequency of bank-full flows which often result from upstream development. Most natural stream channels are formed with a bank-full capacity to pass the runoff from a storm with a 1½ to 2-year recurrence interval. However, in a typical urbanizing watershed, stream channels are subject to a 3- to 5-fold increase in the frequency of bank-full flows. As a result, stream channels that were once parabolic in shape and covered with vegetation are often transformed into wide rectangular channels with barren banks.

In recent years, a number of structural measures have evolved to strengthen and protect the banks of rivers and streams. These methods, if employed correctly, immediately insure a satisfactory protection of the banks. However, many such structures are expensive to build and to maintain and frequently cause downstream velocity problems. Without constant upkeep, they are exposed to progressive deterioration by natural agents. The materials used often prevent the re-establishment of native plants and animals, especially when the design is executed according to standard cross-sections which ignore natural variations of the stream system. Very often these structural measures destroy the appearance of the site.

In contrast, the utilization of living plants instead of or in conjunction with structures has many advantages. The degree of protection, which may be low to start with, increases as the plants grow and spread. The repair and maintenance of structures is unnecessary where self-maintaining streambank plants are established. The protection provided by natural vegetation is more reliable and effective where the cover consists of natural plant communities which are native to the site. Planting vegetation is less damaging to the environment than installing structures. Vegetation also provides habitat for fish and wildlife and is aesthetically pleasing. Plants provide erosion protection to streambanks by reducing stream velocity, binding soil in place with a root mat and covering the soil surface when high flows tend to flatten vegetation against the banks. For these reasons, vegetation should always be considered first.

One disadvantage of vegetation is that it lowers the carrying capacity of the channel, which may promote flooding. Therefore, maintenance needs and the consequences of flooding should be considered. The erosion potential for the stream needs to be evaluated to determine the best solutions. The following items should be considered in the evaluation:

1. The frequency of bankfull flow based on anticipated watershed development.

2. The channel slope and flow velocity, by design reaches.

3. The antecedent soil conditions.

4. Present and anticipated channel roughness ("n") values.

5. The location of channel bends along with bank conditions.

6. The location of unstable areas and trouble spots. Steep channel reaches, high erosive banks and sharp bends may require structural stabilization measures such as riprap, while the remainder of the streambank may require only vegetation.

Where streambank stabilization is required and velocities appear too high for the use of vegetation, one should consider structural measures (see Std. & Spec. 3.23, STRUCTURAL STREAMBANK STABILIZATION) or the use of permanent erosion control matting (see Std. & Spec. 3.36, SOIL STABILIZATION MATTING). Notably, any applicable approval or permits from other state or federal agencies must be obtained prior to working in such areas.

Vegetation Zones Along Watercourses

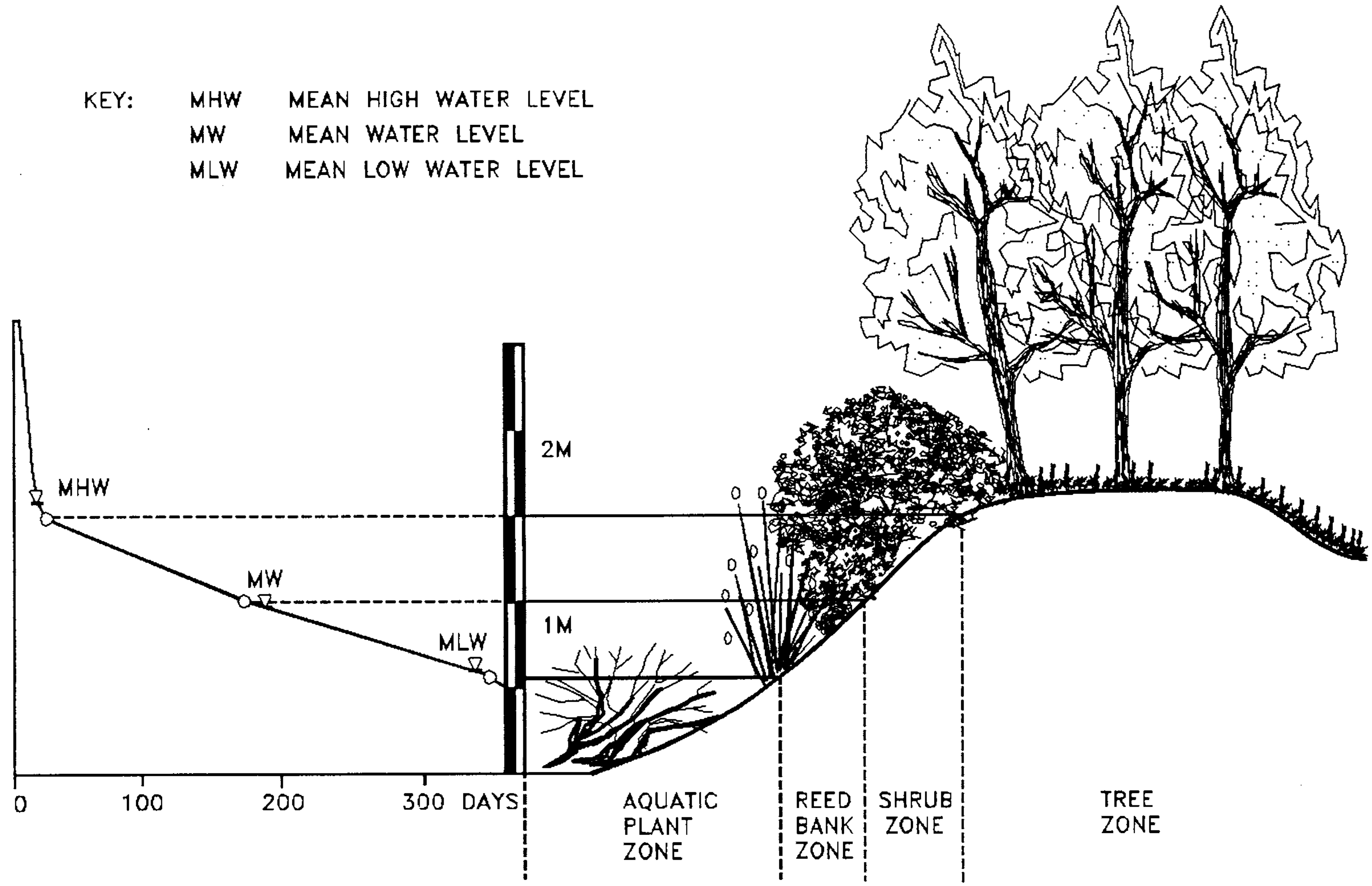
At the edge of all natural watercourses, plant communities exist in a characteristic succession of vegetative zones, the boundaries of which are dependent upon site conditions such as the steepness and shape of the bank and the seasonal and local variations in water depth and flow rate. Streambanks commonly exhibit the following zonation (see Plate 3.22-1):

1. Aquatic Plant Zone - This zone is normally permanently submerged. In Virginia, this zone is inhabited by plants such as pondweeds and water lilies, which reduce the water's flow rate by friction. The roots of these plants help to bind the soil, and they further protect the channel from erosion because the water flow tends to flatten them against the banks and bed of the stream.

2. Reed-Bank Zone - The lower part of this zone is normally submerged for only about half the year. In Virginia, this zone is inhabited by rushes, reed grasses, cattails, and other plants which bind the soil with their roots, rhizomes and shoots and slow the water's flow rate by friction.

3. Shrub Zone - This zone is flooded only during periods of average high water. In Virginia, the shrub zone is inhabited by trees and shrubs--such as willow, alder, dogwood and viburnum--with a high regenerative capacity. These plants hold the soil with their root systems and slow water speed by friction. They also protect tree trunks from damage caused by breaking ice and help to prevent the formation of strong eddies around large trees during flood flows. Shrub zone vegetation is particularly beneficial along the impact bank of a stream meander, where maximum scouring tends to occur. Infringement of shrub vegetation into the channel tends to reduce the channel width, increasing probability of floods. However, brief flooding of riverside woods and undeveloped bottomlands does no significant damage, and the silt deposits in these wooded areas are less of a problem than failed banks.

4. Tree Zone - This zone is flooded only during periods of very high water (i.e., the 2-year bank-full flow or greater flows). Typical plants in Virginia are trees in the ash-elm, alder-ash, and oak-horn-beam associations. These trees hold soil in place with their root systems.



TYPICAL ANNUAL CURVE OF WATER LEVELS CORRELATED WITH TYPICAL VEGETATIVE ZONES

Source: Importance of Natural Vegetation for the Protection of the Banks of Streams, Rivers and Canals, Seibert

Plate 3.22-1

Design Criteria

Table 3.22-A provides general guidelines for maximum allowable velocities in streams to be protected by vegetation.

1. Ensure that channel bottoms are stable before stabilizing channel banks.

2. Keep velocities at bankfull flow non-erosive for the site conditions.

3. Provide mechanical protection such as rip-rap on the outside of channel bends if bankfull stream velocities approach the maximum allowable for site conditions.

4. Be sure that requirements of other state or federal agencies are met in the design in the case that other approvals or permits are necessary.

TABLE 3.22-A

CONDITIONS WHERE VEGETATIVE STREAMBANK STABILIZATION IS ACCEPTABLE

Frequency of Bankfull Flow	Max. Allowable Velocity for Highly Erodible Soil	Maximum Allowable Velocity (Erosion Resistant Soil)
> 4 times/yr.	4 ft./sec.	5 ft./sec.
1 to 4 times/yr.	5 ft./sec.	6 ft./sec.
< 1 time/yr.	6 ft./sec.	6 ft./sec.

Source: Va. DSWC

Planting Guidelines

Guidelines will be presented only for the reed-bank and shrub zones. The aquatic plant zone is difficult to implant and establish naturally when reed-bank vegetation is present. There are presently many experts in this field at the federal, state, and private sector levels who can be consulted concerning successful establishment of plants in the aquatic zone. The tree zone is least significant in terms of protecting banks from more frequent erosion-force flows, since this zone is seldom flooded. Also, shade from trees in this zone can prevent adequate establishment of vegetation in other zones.

1. Establishing Reed-Bank Vegetation

There are various ways of planting reed-bank vegetation. The following plants are considered suitable:

Common Reed	(Phragmites communis)
Reed Canary Grass	(Phalaris arundinacae)
Great Bulrush	(Scirpus lacustris)
Common Cattail	(Typha latifolia)

The greatest protection seems to be provided by the Common Reed. It is a very robust plant whose stems become woody in the autumn, resulting in continued protection during the winter. Because the shoots and rhizomes are deeply and strongly rooted and densely intertwined, they bind the soil more firmly than any other reed. The stems and roots have dormant buds at the nodes and are capable of sprouting when planted. However, the Common Reed does grow high and thick, and periodic maintenance may be needed in order to achieve a neat appearance.

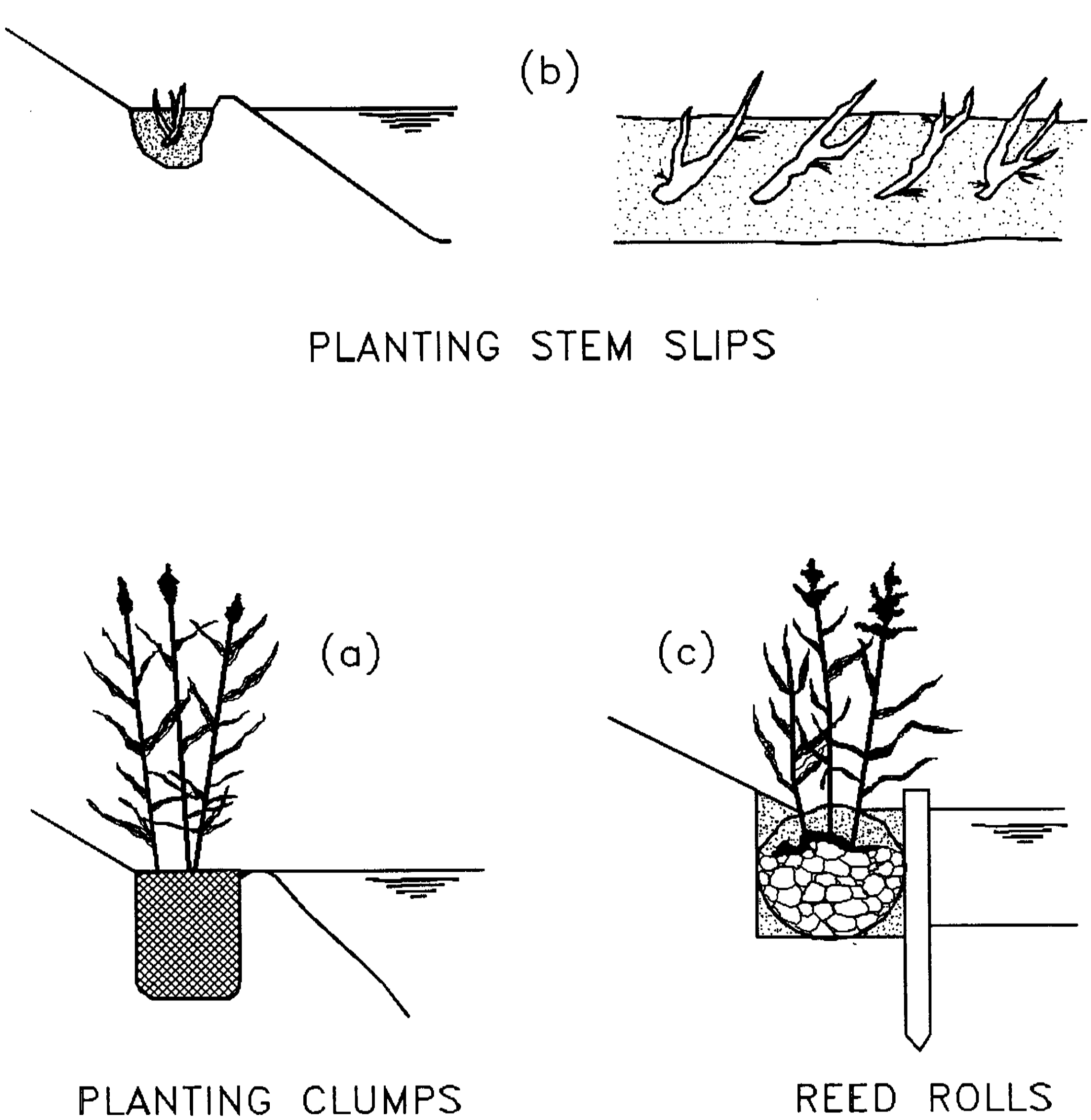
a. Planting in Clumps: The oldest and most common method of planting reeds is planting in clumps (see Plate 3.22-2 (a)). The stems of the reed colony are scythed. Then square clumps are cut out of the ground and placed in pits prepared in advance on the chosen site. The clumps are planted at a depth where they will be submerged to a maximum of two-thirds of their height.

b. Planting Rhizomes and Shoots: Less material is needed for the planting of rhizomes and shoots, a procedure which can be used to establish the Common Reed, Reed Grass, Bulrush, Cattail and other plants. Slips are taken from existing beds during the dormant season, after the stems have been cut. Rhizomes and shoots are carefully removed from the earth without bruising the buds or the tips of the sprouts. They are placed in holes or narrow trenches, along the line of the average summer water level, so that only the stem sprouts are showing above the soil.

c. Planting Stem Slips: It is possible to plant stem slips of the Common Reed along slow-moving streams (see Plate 3.22-2 (b)). Usually, three slips are set in a pit 12 to 20 inches deep. If the soil is packed or strong, the holes must be made with a dibble bar or some other metal planting tool. The pits should be located approximately 1 foot apart.

d. Reed Rolls: In many cases, the previously described methods do not consolidate the banks sufficiently during the period immediately after planting. Combined structures have therefore been designed, in which protection of the bank is at first insured by structural materials. Along slow to fairly fast

METHODS OF ESTABLISHING REED BANK VEGETATION



Source: Importance of Natural Vegetation for the Protection of the Banks of Streams, Rivers and Canals, Seibert

Plate 3.22-2

streams, the most effective method of establishing reed-bank vegetation has been found to be the use of Reed Rolls (see Plate 3.22-2 (c)). A trench 18 inches wide and deep is dug behind a row of stakes. Wire netting, such as ½-inch hardware cloth, is then stretched from both sides of the trench between upright planks. Onto this netting is dumped fill material such as coarse gravel, sod, or soil and other organic material. This material is then covered by reed clumps until the two edges of the wire netting can just be held together with wire. The upper edge of the roll should be no more than 2 inches above the level of the water. Finally, the planks are taken out, and any gaps along the sides of the roll are filled in with earth. This method provides greater protection from the possibility of a heavy flow washing away the vegetative materials before they have a chance to become established.

e. Seeding: Reed Canary Grass can be sown 1/2-inch deep on very damp bank soil, provided that the seeded surface is not covered by water for six months after sowing. Seed at a rate of 12-15 lbs./acre. Reed Canary Grass is a cool season grass and should not be seeded in the summer.

f. Vegetation and Stone Facing: Reed-bank and other types of vegetation can be planted in conjunction with rip-rap or other stone facing by planting clumps, rhizomes or shoots in the crevices and gaps along the line of the average summer water level.

2. Establishing Shrub Zone Vegetation: Stands of full-grown trees are of little use for protecting streambanks apart from the binding of soil with their roots. Shrubwood provides much better protection; and in fact, riverside stands of willow trees are often replaced naturally by colonies of shrub-like willows. Plants should be used which can easily adapt to the stream and site conditions.

a. Seeding and Sodding: Frequently, if the stream is small and a good seedbed can be prepared, grasses can be used alone to stabilize the streambanks. To seed the shrub zone, first grade eroded or steep streambanks to a maximum slope of 2:1 (3:1 preferred). Existing trees greater than 4 inches in diameter should be retained whenever possible. Topsoil should be conserved for re-use. Seeding mixtures should be selected and operations performed according to Std. & Spec. 3.32, PERMANENT SEEDING. Some type of erosion control blanket, such as jute netting, excelsior blankets, or equivalent should be installed according to Std. & Spec. 3.36, SOIL STABILIZATION BLANKETS & MATTING. Sod can also be placed in areas where grass is suitable. Sod should be selected and installed according to Std. & Spec. 3.33, SODDING. Turf should only be used where the grass will provide adequate protection, necessary maintenance can be provided, and establishment of other streambank vegetation is not practical or possible.

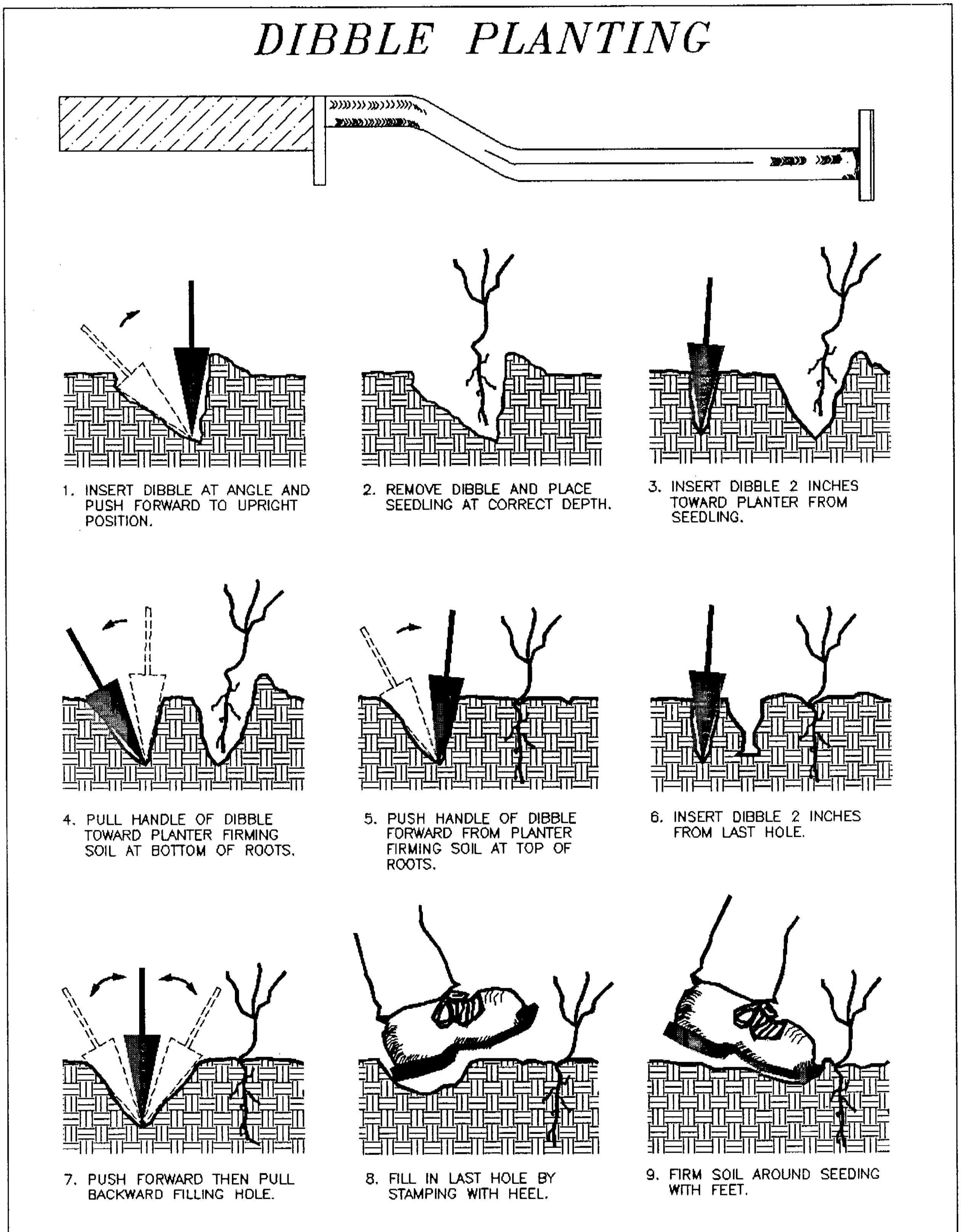
b. <u>Planting Cuttings and Seedlings</u>: Shrub willows, shrub dogwoods and alders can be put into the soil as cuttings, slips or stems. In dense shade, shrubs such as the Blue Arctic Willow (Salix purpurea nana) and the Silky Dogwood (Cornus amomum) or evergreen ground covers such as Lily Turf (Liriope Muscari) or Hall's Honeysuckle (Linicera hallsiana) are appropriate. The Silky Dogwood also works well in sunny areas. On larger streams, "Streamco" Purpleosier Willow (Salix purpurea "Streamco") and Bankers' Dwarf Willow (Salix x Cotteti) have been widely used with success. Two native river alders (Alnus serrulata and Alnus rugosa), which occur throughout the northeast, also show great promise for streambank stabilization, although they have not been fully tested. Again, the first step in the planting process is to grade eroded or steep slopes to a maximum slope of 2:1 (3:1 preferred), removing overhanging bank edges.

Willows can be planted as 1-year old, nursery-grown, rooted cuttings or as fresh hardwood cuttings gathered from local mother-stock plantings. Silky Dogwood and the alders should be nursery-grown seedlings 1 or 2 years old. Fresh cuttings should be 3/8- to 1/2-inch thick and 12 to 18 inches long. They should be kept moist. If not used at once, they should be stored in cool moist sand.

Streambanks are often difficult to plant, even when they are well-sloped. This is especially true in gravelly or strong banks. Where mattocks or shovels are unsatisfactory tools, a stiff steel bar, such as a crowbar, is better. The best tool for this purpose is a dibble bar, a heavy metal tool with a blade and a foot pedal. It is thrust into the ground to make a hole for the plant (see Plate 3.22-3).

Rooted cuttings should be planted vertically in the bank with 1 or 2 inches of wood protruding above the ground surface. They should be stuck in a hole large enough to accommodate the root system when well spread. The plant roots must be maneuvered into the bottom of the hole so they will grow down instead of up. The roots should not be twisted, nor should they be exposed above the ground surface. After the plant is placed, the dibble bar can be installed a few inches away from the plant to close the hole. Slow-release fertilizer should be applied on the surface, <u>not in the hole</u>. The soil should be tamped adequately to provide complete contact between the soil and the cutting. Cuttings should be planted 1 foot on center in at least 3 rows located at the top, middle and bottom of the shrub zone.

Plant seedings of the river alders vertically in the bank to the depth they were growing in the nursery. Use the same procedure described previously. Plant one row of alders at 2-foot intervals at the base of the shrub zone, not more than 1.5 to 3 feet from the average summer water level or from the reeds. A greater distance is of no use unless a belt of tall perennial herb colonies is established between the reeds and the alders. Plant the next row 2 feet up



Source: <u>A Guide For Vegetating Surface-Mined Lands For Wildlife in Eastern Kentucky and West Virginia</u>, USDI-Fish and Wildlife Service

Plate 3.22-3

the slope, with a third row 4 feet up the slope. Plant at least 3 rows. Locate the plants in a diamond pattern.

Since these plants are generally not effective for the first two years, grasses can be seeded immediately following their planting to provide initial streambank protection. The seed mixtures noted in Table 3.22-B are appropriate plantings.

TABLE 3.22-B

INITIAL STREAMBANK PLANTINGS: SEED MIXTURES BY REGION*

Appalachian Region	Piedmont Region	Coastal Plain
Kentucky-31 Tall Fescue: 65 lbs./acre Creeping Red Fescue: 15 lbs./acre Redtop Grass: 5 lbs./acre	Kentucky-31 Tall Fescue: 80 lbs./acre. Redtop Grass: 5 lbs./acre	Kentucky-31 Tall Fescue: 65 lbs./acre Bermudagrass: 15 lbs./acre Redtop Grass: 5 lbs./acre
* Physiographic Regions are described in Std. & Spec. 3.32, PERMANENT SEEDING.		

Source: Va. DSWC

The seedbed should be roughened with rakes and fertilized with 500 to 1000 pounds per acre of 10-10-10, adjusted to meet the needs of the site. Special care should be used when fertilizing next to water sources to avoid any unnecessary introduction of nitrogen/phosphorus into the water. Seed should be broadcast, covered lightly and mulched with 2 tons of straw per acre (2-3 bales per 1000 square feet) or a minimum of 1500 pounds of wood fiber mulch per acre (2000 pounds per acre preferred). If straw is used, it should be properly anchored with netting or an effective tackifier. Erosion control blankets/mats are often very effective aids in the establishment of grasses or plant material along streambanks (see Std. & Spec. 3.36, SOIL STABILIZATION BLANKETS & MATTING).

Willows and other softwoods can also be bound together in various ways in order to insure immediate protection of the streambank.

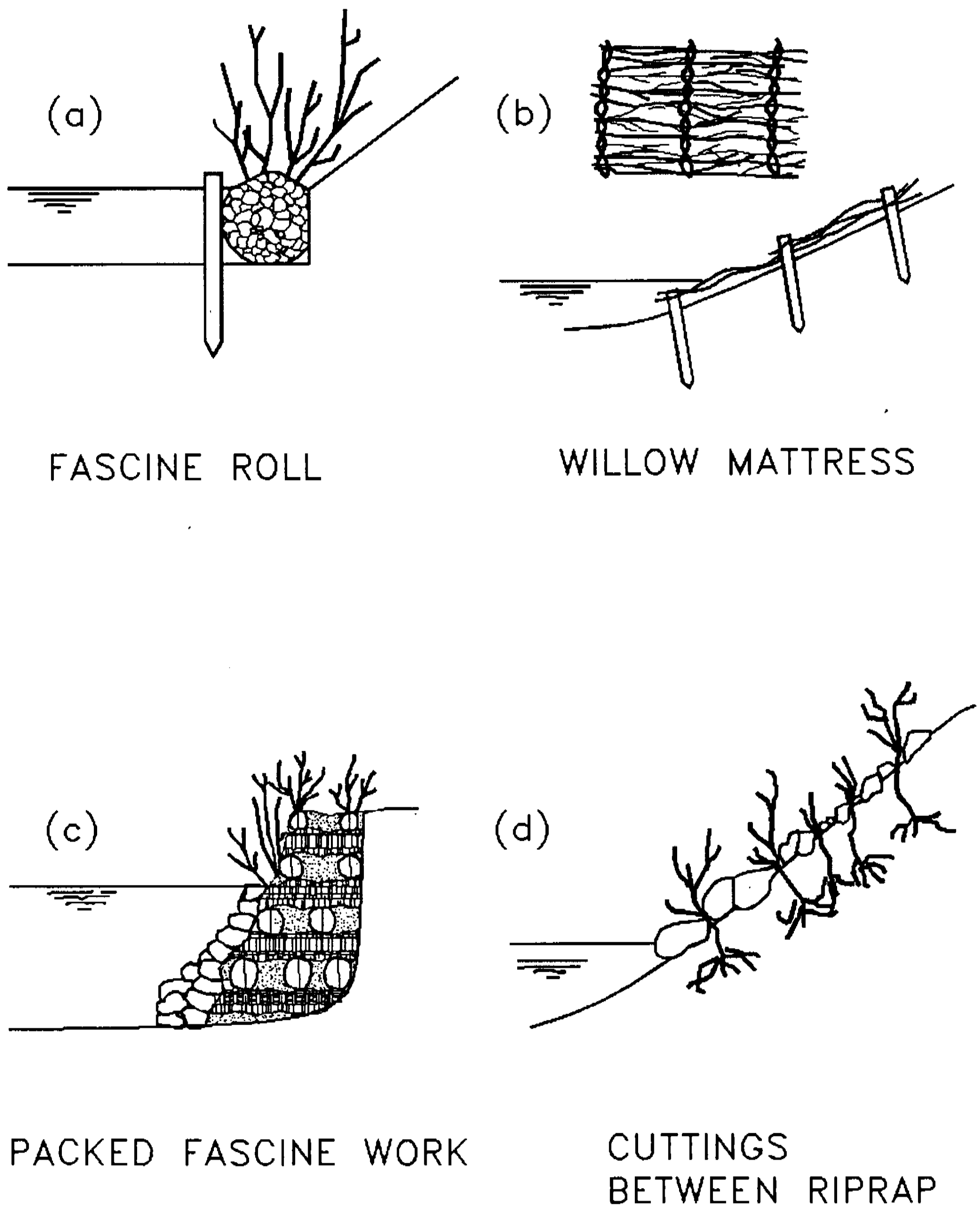
c. Fascine Rolls: Fascine rolls are bundles of brushwood and sticks, without branches if possible, that are filled with coarse gravel and rubble and wired tightly around the outside. They are 4 to 20 yards long and 4 to 16 inches in diameter. They are set against the bank so that the parts which are to take root touch the ground above the water level and are able to get sufficient moisture. Covering with earth improves the contact with the ground and retards the loss of moisture from the wood (see Plate 3.22-4 (a)).

d. Willow Mattresses: The degree of streambank protection can be increased by using willow mattresses or packed fascine work. Willow mattresses consist of 4- to 8-inch thick layers of growing branches set perpendicular to the direction of the current or sloping downstream. with the broad ends of the branches oriented downwards. The branches are held together with interweaving wire or other branches at intervals of 24 to 32 inches, set parallel to the direction of the current or at an angle of 30 degrees. If several layers of mattress are necessary, the tops of the lower layers should cover the bases of the upper layers. The bottom layer is fixed at the base in a trench previously dug at the base of the softwood zone. The whole mattress structure should be covered with 2 to 10 inches of earth or fine gravel (Plate 3.22-4 (b)).

e. Packed Fascine-Work: Packed fascine-work [Plate 3.22-4 (c)] consists essentially of layers of branches laid one across the other to a depth of 8 to 12 inches and covered with fascine rolls. The spaces between the fascine rolls are filled with gravel, stones and soil so that no gaps remain; and a layer of soil and gravel 8 to 12 inches thick is added on top. Packed fascine-work is particularly suitable for repairing large breaches in the banks of streams with high water levels.

f. Combination with Stone Facing: In many places, the bank is not adequately protected by vegetation until the roots are fully developed, and temporary protection must be provided by inanimate materials. There is a wide choice of methods, including the planting of woody plants in the crevices of stone facing (Plate 3.22-4 (d)). For structural protection measures, see Std. & Spec. 3.23, STRUCTURAL STREAMBANK PROTECTION.

METHODS OF ESTABLISHING SHRUB ZONE VEGETATION



Source: Importance of Natural Vegetation for the Protection of the Banks of Streams, Rivers and Canals, Seibert

Plate 3.22-4

Maintenance

Streambanks are always vulnerable to new damage. Repairs are needed periodically. Banks should be checked after every high-water event is over. Gaps in the vegetative cover should be fixed at once with new plants, and mulched if necessary. Fresh cuttings from other plants on the bank can be used, or they can be taken from mother-stock plantings if they are available. Trees that become established on the bank should be removed at once.

STD & SPEC 3.23

STRUCTURAL STREAMBANK STABILIZATION

SSS

Definition

Methods of stabilizing the banks of live streams with permanent structural measures.

Purpose

To protect streambanks from the erosive forces of flowing water.

Conditions Where Practice Applies

Applicable to streambank sections which are subject to excessive erosion due to increased flows or disturbance during construction. Generally applicable where flow velocities exceed 5 ft./sec. or where vegetative streambank protection is inappropriate.

Planning Considerations

Stream channel erosion problems vary widely in type and scale and there are many different structural stabilization techniques which have been employed with varying degrees of effectiveness. The purpose of this specification is merely to point out some of the practices which are available and to establish some broad guidelines for their selection and design. Such structures should be planned and designed in advance by an engineer or some other qualified individual with appropriate experience. Many of the practices referenced here involve the use of manufactured products and should be designed and installed in accordance with the manufacturers' specifications.

Before selecting a structural stabilization technique, the designer should carefully evaluate the possibility of using vegetative stabilization (Std. & Spec. 3.22) alone or in conjunction with structural measures, to achieve the desired protection. Vegetative techniques are generally less costly and more compatible with natural stream characteristics.

General Guidelines

Since each reach of channel requiring protection is unique, measures for streambank protection should be installed according to a plan and adapted to the specific site. Designs should be developed according to the following principles:

1. Protective measures to be applied shall be compatible with improvements planned or being carried out by others.

2. The bottom scour should be controlled, by either natural or artificial means, before any permanent type of bank protection can be considered feasible. This is not necessary if the protection can be safely and economically constructed to a depth well below the anticipated lowest depth of bottom scour.

3. Streambank protection should be started and ended at a stabilized or controlled point on the stream.

4. Changes in channel alignment shall be made only after an evaluation of the effect upon land use, interdependent waste water systems, hydraulic characteristics and existing structures.

5. Special attention should be given to maintaining and improving habitat for fish and wildlife.

6. The design velocity should be that of the peak discharge of the 10-year storm. Structural measures must be effective for this design flow and must be capable of withstanding greater flows without serious damage.

7. All requirements of state law and permit requirements of local, state and federal agencies must be met.

8. Stabilize all areas disturbed by construction as soon as the structural measures are complete.

Streambank Protection Measures

Riprap - heavy angular stone placed (preferably) or dumped onto the streambank to provide armor protection against erosion. Riprap shall be designed and installed according to the practice entitled RIPRAP (Std. & Spec. 3.19).

Gabions - rectangular, rock-filled wire baskets are pervious, semi-flexible building blocks which can be used to armor the bed and/or banks of channels or to divert flow away from eroding channel sections. Gabions should be designed and installed in accordance with manufacturer's standards and specifications (see Plate 3.23-1). At a minimum, they should be constructed of a hexagonal triple twist mesh of heavily galvanized steel wire (galvanized wire may also receive a poly-vinyl chloride coating). The design water velocity for channels utilizing gabions should not exceed that given below:

Gabion Thickness (feet)	Maximum Velocity (feet per second)
1/2	6
3/4	11
1	14

Deflectors (groins or jetties) - Structural barriers which project into the stream to divert flow away from eroding streambank sections. Plate 3.23-2 contains general guidelines for designing and installing deflectors.

Installation of Structures Under Wave and/or Tidal Action

The installation of riprap, gabions or deflectors under significant wave action or under tidal conditions requires special design considerations to ensure stability of the measure and the area it protects. The design/installation of these measures for tidal areas is beyond the scope of the Virginia Erosion and Sediment Control Law and Virginia Erosion and Sediment Control Regulations. The DSWC's Shoreline Programs Bureau can be consulted in regard to minimum design parameters for tidal installations. For situations where there is significant wave action affecting the shoreline of a nontidal lake or pond, the design parameters presented in Std. & Spec. 3.19, RIPRAP, should be used. Notably, there are many other site specific factors which should be incorporated into a design; hence, it is recommended that the design parameters presented only be used as minimum requirements and that a qualified professional be consulted when the installation of such a structure is contemplated.

Reinforced Concrete - may be used to armor eroding sections of the streambank by constructing retaining walls or bulk heads. Positive drainage behind these structures must be provided. Reinforced concrete may also be used as a channel lining (see Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNEL).

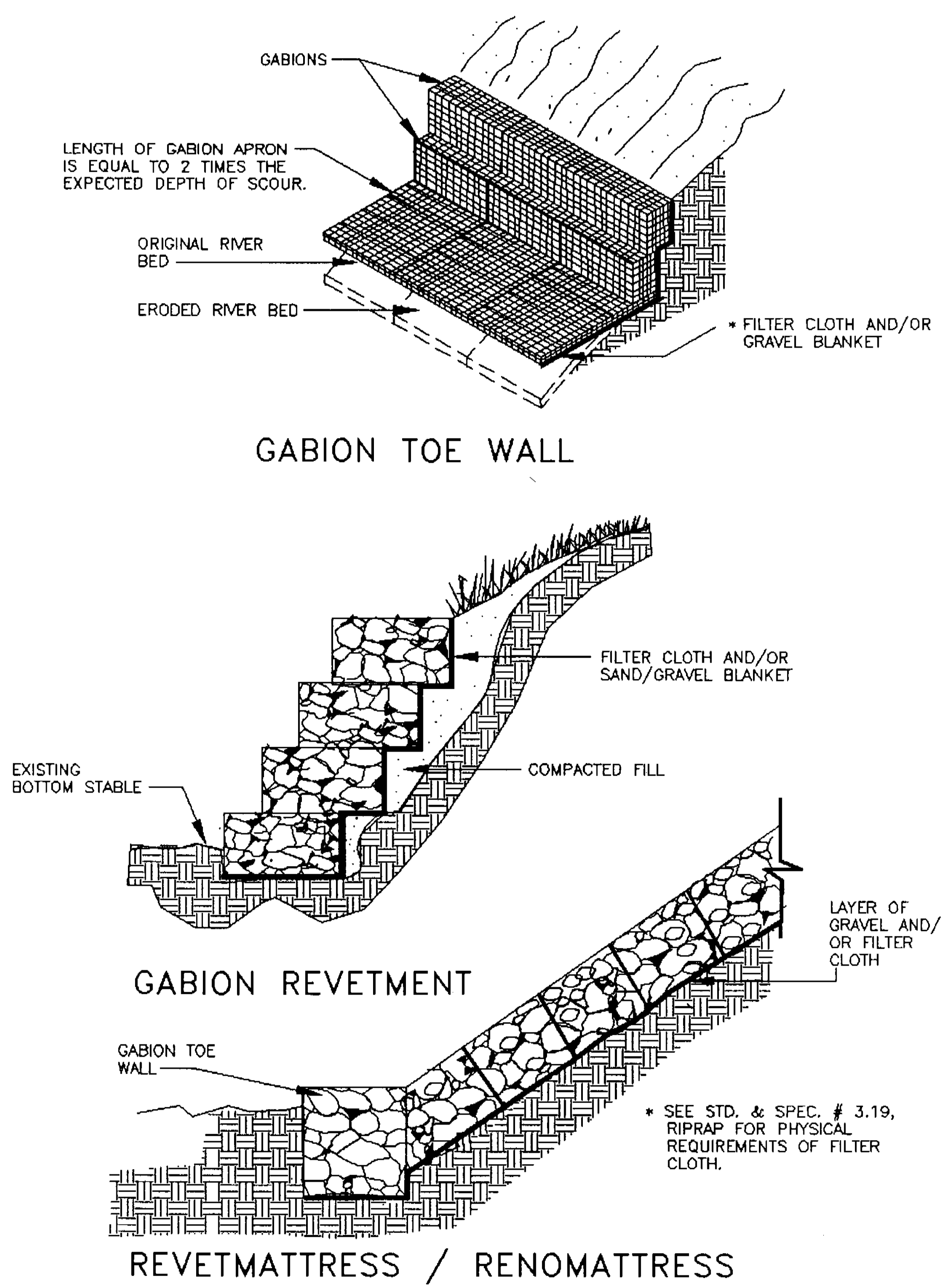
Log Cribbing - a retaining structure built of logs to protect streambanks from erosion. Log cribbing is normally built on the outside of stream bends to protect the streambank from the impinging flow of the stream (see Plate 3.23-3).

Grid Pavers - modular concrete units with interspersed void areas which can be used to armor the streambank while maintaining porosity and allowing the establishment of vegetation. These structures may be obtained in pre-cast blocks or mats, or they may be formed and poured in place. Design and installation should be in accordance with manufacturer's instructions (see Plate 3.23-4).

Maintenance

All structures should be maintained in an "as built" condition. Structural damage caused by storm events should be repaired as soon as possible to prevent further damage to the structure or erosion of the streambank.

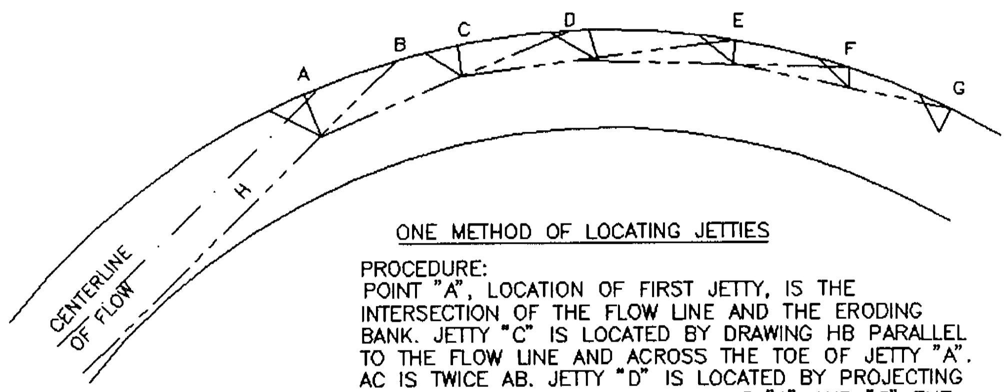
GABIONS



Source: Adapted from product literature of Bekaert Gabions

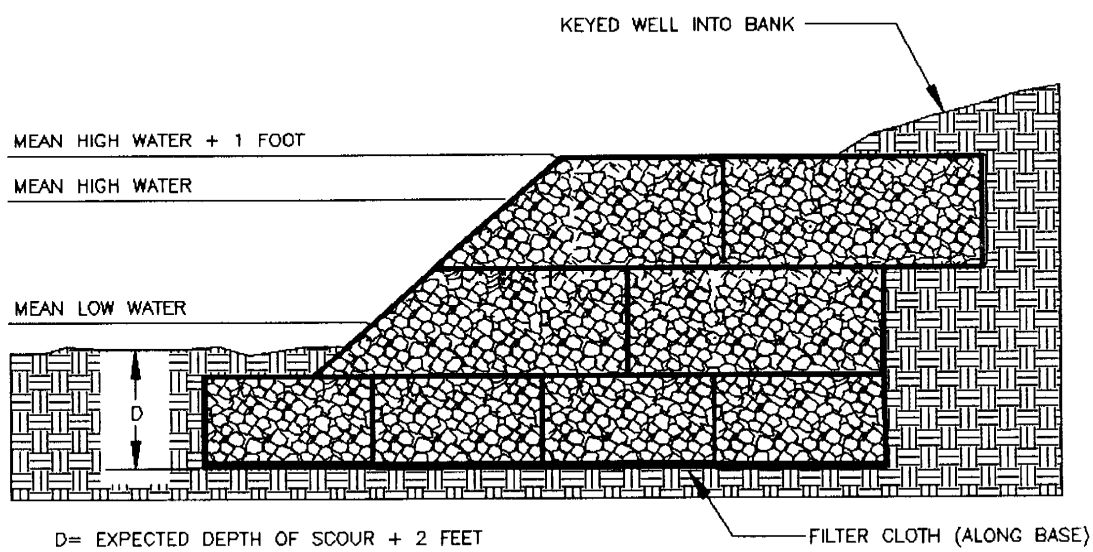
Plate 3.23-1

DEFLECTORS



ONE METHOD OF LOCATING JETTIES

PROCEDURE:
POINT "A", LOCATION OF FIRST JETTY, IS THE INTERSECTION OF THE FLOW LINE AND THE ERODING BANK. JETTY "C" IS LOCATED BY DRAWING HB PARALLEL TO THE FLOW LINE AND ACROSS THE TOE OF JETTY "A". AC IS TWICE AB. JETTY "D" IS LOCATED BY PROJECTING A LINE ACROSS THE TOE OF JETTIES "A" AND "C". THE REMAINING JETTIES ARE LOCATED THE SAME AS "D". SUPPLEMENTARY JETTY "K" IS LOCATED AC DISTANCE UPSTREAM FROM "A".

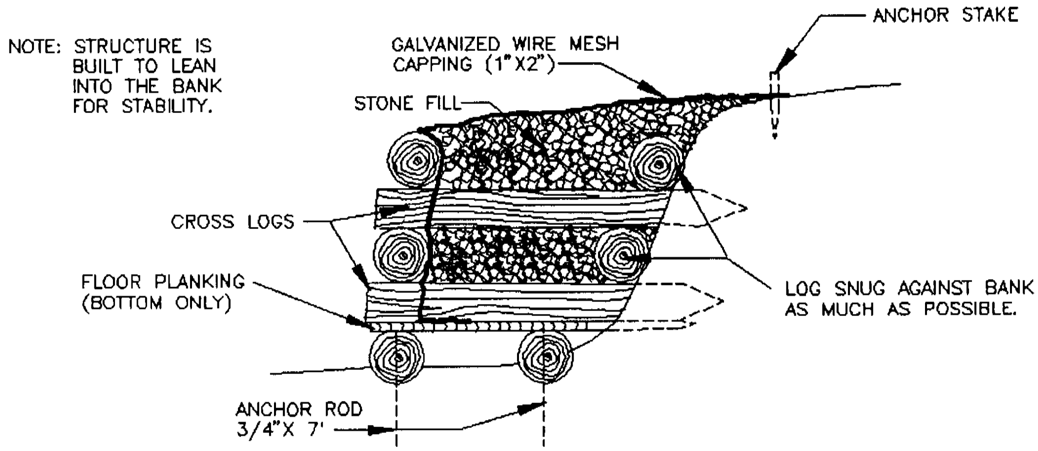


TYPICAL GABION DEFLECTOR

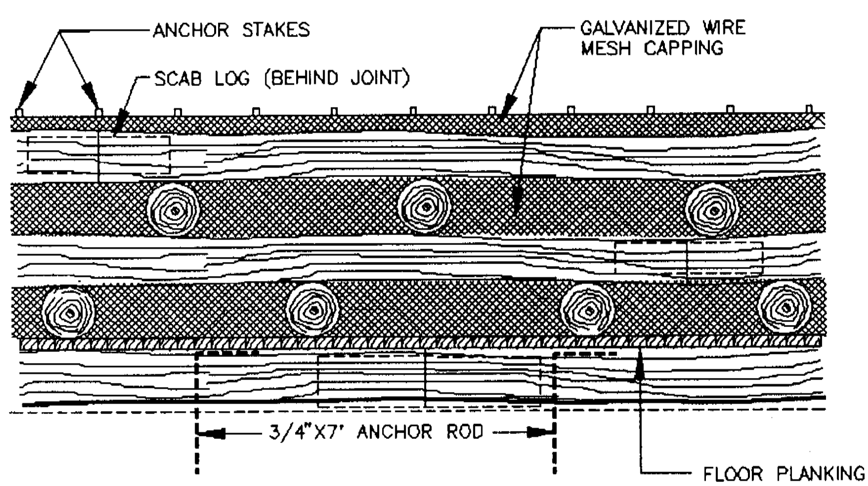
Source: Adapted from product literature of Bekaert Gabions

Plate 3.23-2

LOG CRIBBING



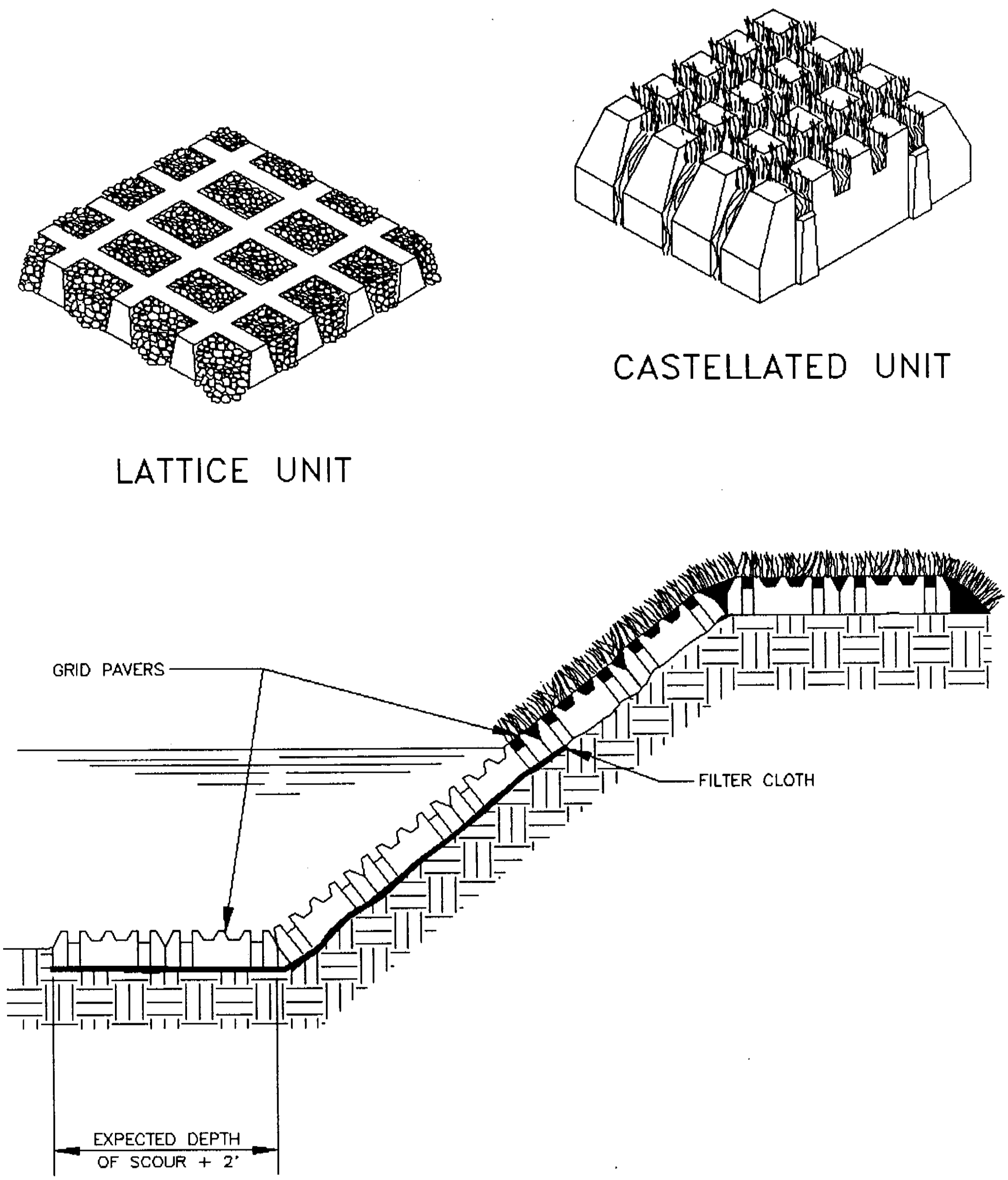
SIDE VIEW



FRONT VIEW

Source: Introductory Guide to Stream Improvement Plate 3.23-3

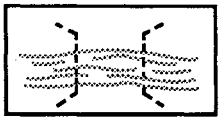
GRID PAVERS



Source: Va. DSWC

Plate 3.23-4

STD & SPEC 3.24



TEMPORARY VEHICULAR STREAM CROSSING

SC

Definition

A temporary structural span installed across a flowing watercourse for use by construction traffic. Structures may include bridges, round pipes, pipe arches, or oval pipes.

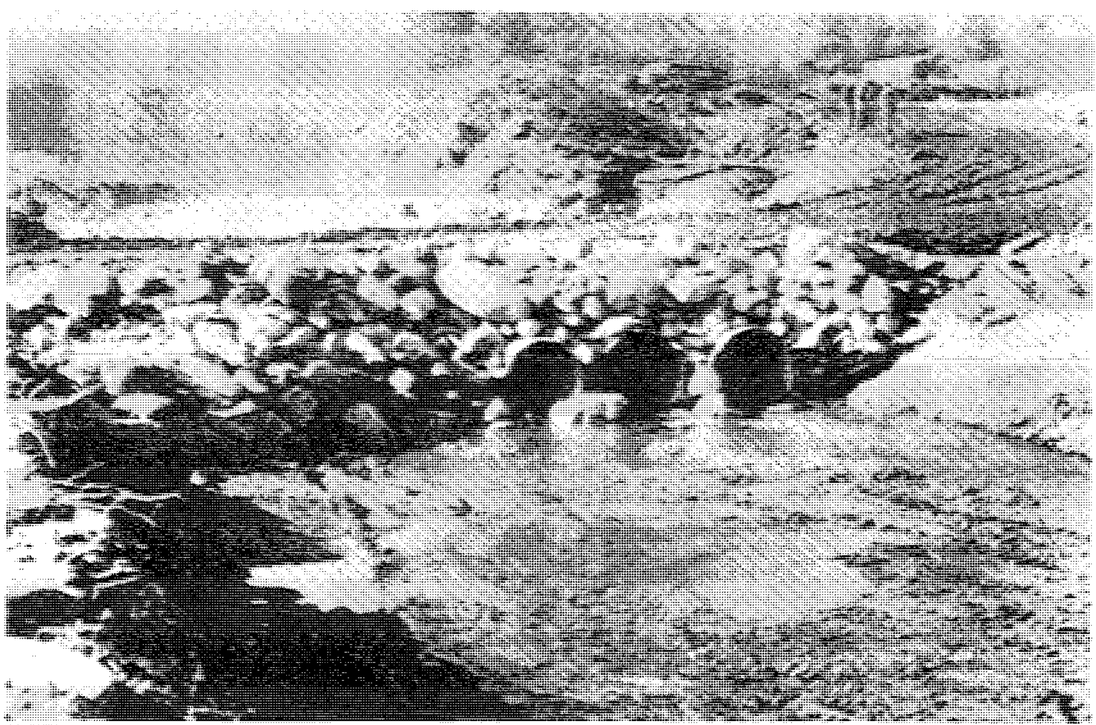
Purposes

1. To provide a means for construction traffic to cross flowing streams without damaging the channel or banks.

2. To keep sediment generated by construction traffic out of the stream.

Conditions Where Practice Applies

Generally applicable to flowing streams with drainage areas less than 1 square mile. Structures which must handle flow from larger drainage areas should be designed by methods which more accurately define the actual hydrologic and hydraulic parameters which will affect the functioning of the structure.



Planning Considerations

Temporary stream crossings are necessary to prevent construction vehicles from damaging streambanks and continually tracking sediment and other pollutants into the flow regime. These structures are, however, also undesirable in that they represent a channel constriction which can cause flow backups or washouts during periods of high flow. For this reason, the temporary nature of stream crossings is stressed. They should be planned to be in service for the shortest practical period of time and to be removed as soon as their function is completed.

The specifications contained in this section pertain primarily to flow capacity and resistance to washout of the structure. From a safety and utility standpoint, the designer must also be sure that the span is capable of withstanding the expected loads from heavy construction equipment which will cross the structure. The designer must also be aware that such structures are subject to the rules and regulations of the U. S. Army Corps of Engineers for in-stream modifications (404 permits).

A temporary bridge crossing is a structure made of wood, metal, or other materials which provides access across a stream or waterway. It is the preferred method for temporary waterway crossings. Normally, bridge construction causes the least amount of disturbance to the stream bed and banks when compared to the other types of crossings. They can also be quickly removed and reused. In addition, temporary bridges pose the least chance for interference with fish migration when compared to the other temporary access waterway crossings. A temporary culvert crossing is a structure consisting of stone and a section(s) of circular pipe, pipe arches, or oval pipes of reinforced concrete, corrugated metal, or structural plate, which is used to convey flowing water through the crossings. Temporary culverts are used where the channel is too wide for normal bridge construction or the anticipated loading of construction vehicles may prove unsafe for single span bridges. There is some disturbance within the stream during construction and removal of the temporary culvert crossing. The stone, along with the temporary culverts, can be salvaged and reused.

Design Criteria

1. Temporary Bridge Crossing

   a. Structures may be designed in various configurations. However, the materials used to construct the bridge must be able to withstand the anticipated loading of the construction traffic. Plate 3.24-1 shows on example of such a crossing.

   b. Crossing Alignment - The temporary waterway crossing shall be at right angles to the stream. Where approach conditions dictate, the crossing may vary 15° from a line drawn perpendicular to the center line of the stream at the intended crossing location.

TEMPORARY BRIDGE CROSSING

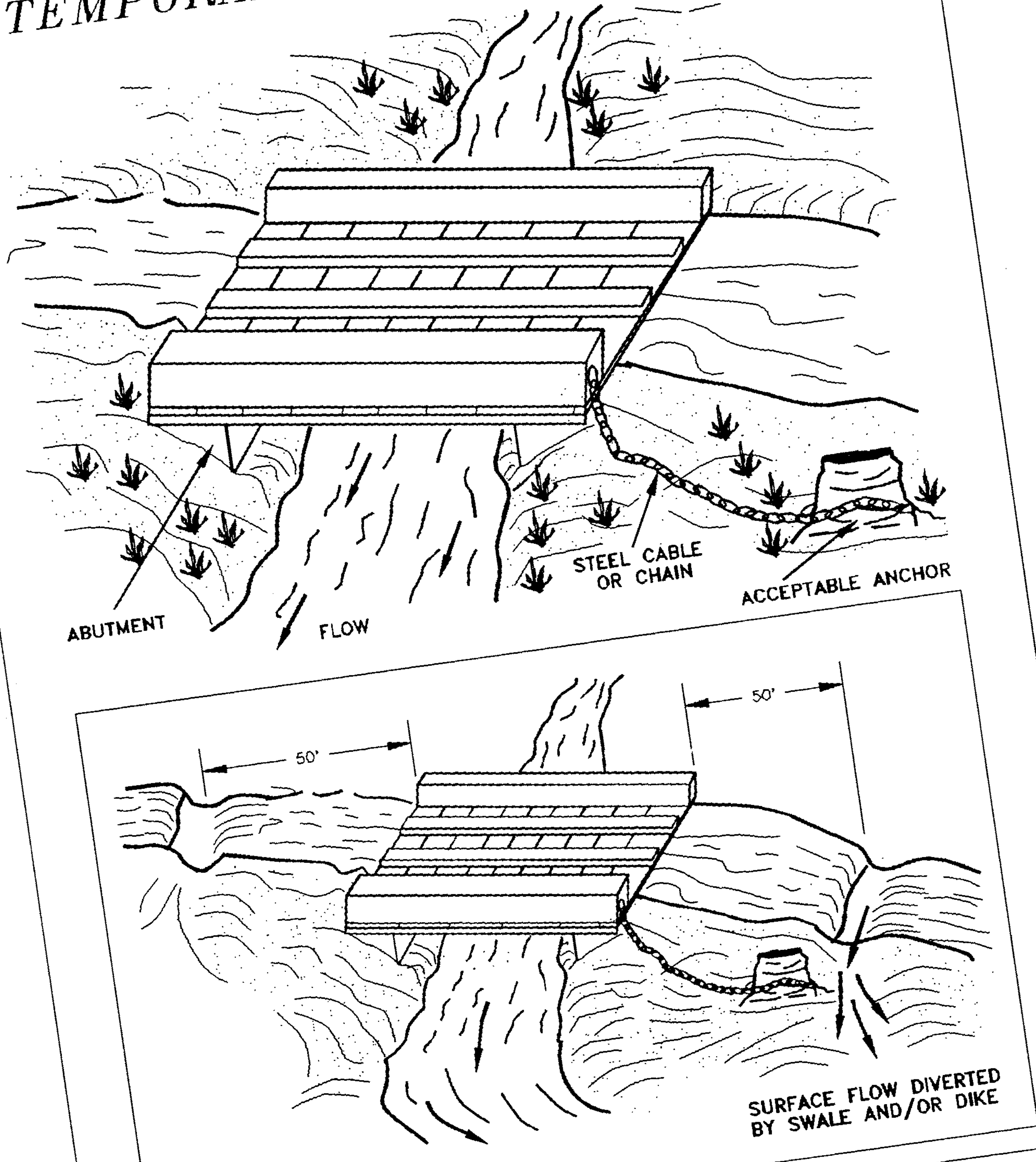


Plate 3.24-1

Source: <u>1983 Maryland Standards and Specifications for Soil Erosion and Sediment Control</u>

c. The centerline of both roadway approaches shall coincide with the crossing alignment centerline for a minimum distance of 50 feet from each bank of the waterway being crossed. If physical or right-of-way restraints preclude the 50 feet minimum, a shorter distance may be provided. All fill materials associated with the roadway approach shall be limited to a maximum height of 2 feet above the existing flood plain elevation.

d. A water diverting structure such as a dike or swale shall be constructed (across the roadway on both roadway approaches) 50 feet (maximum) on either side of the waterway crossing. This will prevent roadway surface runoff from directly entering the waterway. The 50 feet is measured from the top of the waterway bank. Design criteria for this diverting structure shall be in accordance with Std. & Spec. 3.11, TEMPORARY RIGHT OF WAY DIVERSION or Std. & Spec. 3.09, TEMPORARY DIVERSION DIKE. If the roadway approach is constructed with a reverse grade away from the waterway, a separate diverting structure is not required.

e. Appropriate perimeter controls such as SILT FENCE (Std. & Spec. 3.05) or TURBIDITY CURTAIN (Std. & Spec. 3.27) must be employed when necessary along banks of stream parallel to the same.

f. All crossings shall have one traffic lane. The minimum width shall be 12 feet with a maximum width of 20 feet.

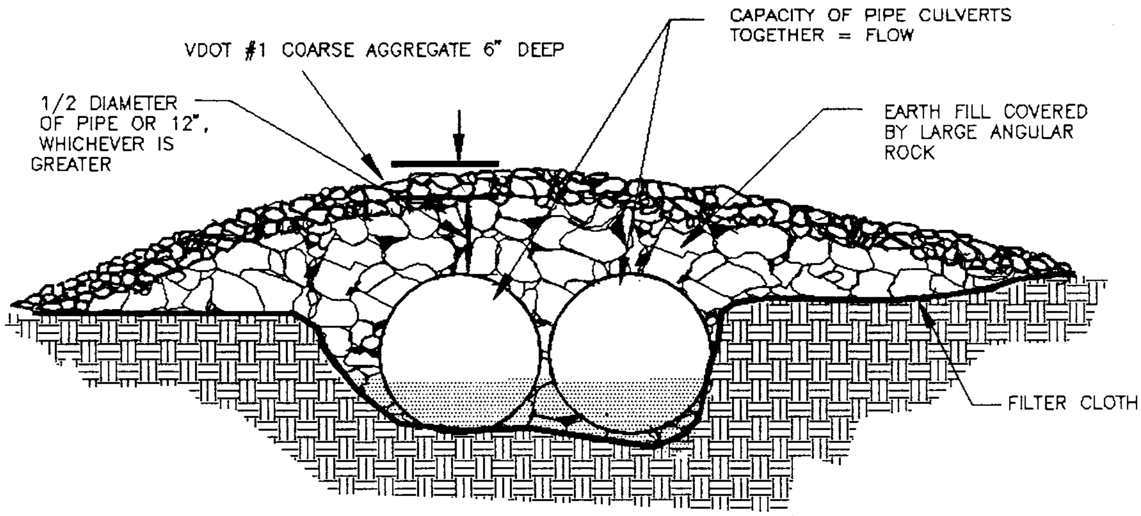
g. Further design/construction recommendations for temporary bridge construction may be found in Construction Specifications.

2. Temporary Culvert Crossing

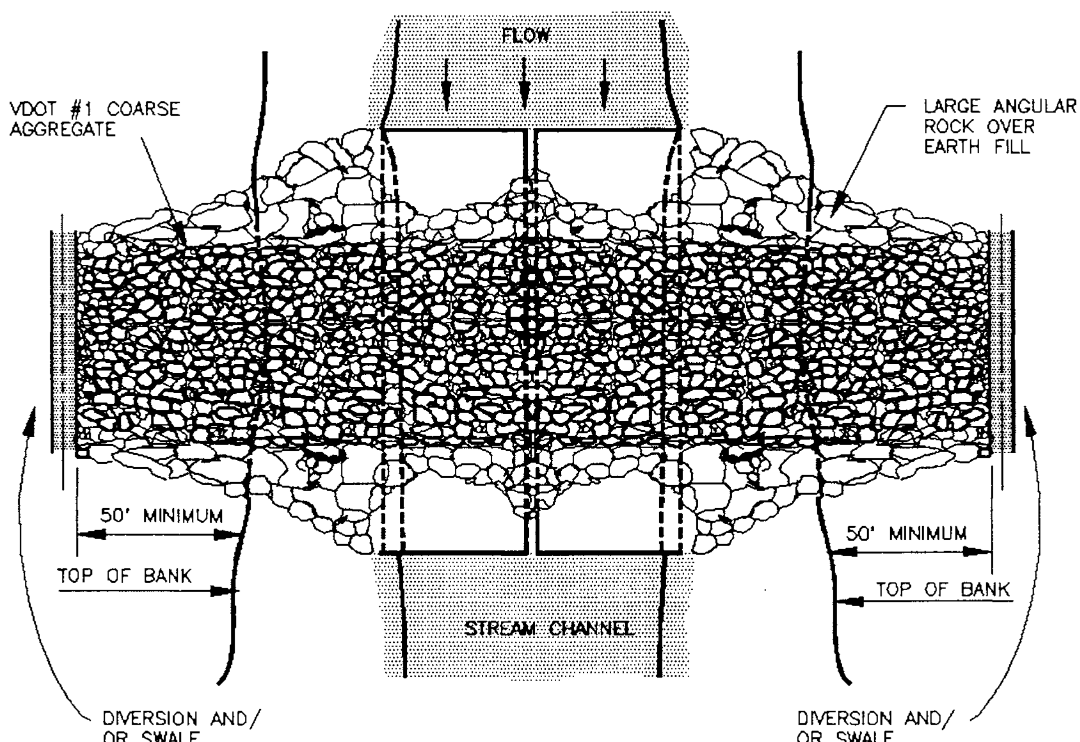
a. Where culverts are installed, VDOT #1 Coarse Aggregate or larger will be used to form the crossing. The depth of stone cover over the culvert shall be equal to one-half the diameter of the culvert or 12 inches, whichever is greater. To protect the sides of the stone from erosion, riprap shall be used and designed in accordance with Std. & Spec. 3.19, RIPRAP (see Plate 3.24-2).

b. If the structure will remain in place for up to 14 days, the culvert shall be large enough to convey the flow from a 2-year frequency storm without appreciably altering the stream flow characteristics. See Table 3.24-A for aid in selecting an appropriate culvert size (note all assumptions). If the structure will remain in place 14 days to 1 year, the culvert shall be large enough to convey the flow from a 10-year frequency storm. In this case, the hydrologic calculation and subsequent culvert size must be done for the specific watershed characteristics. If the structure must remain in place over 1 year, it must be designed as a permanent measure by a qualified professional.

TEMPORARY CULVERT CROSSING



ELEVATION



PLAN VIEW

Source: Va. DSWC

Plate 3.24-2

c. Multiple culverts may be used in place of one large culvert if they have the equivalent capacity of the larger one. The minimum-sized culvert that may be used is 18 inches.

d. All culverts shall be strong enough to support their cross-sectioned area under maximum expected loads.

e. The length of the culvert shall be adequate to extend the full width of the crossing, including side slopes.

f. The slope of the culvert shall be at least 0.25 inch per foot.

g. Crossing Alignment - The temporary waterway crossing shall be at right angles to the stream. Where approach conditions dictate, the crossing may vary 15° from a line drawn perpendicular to the centerline of the stream at the intended crossing location.

h. The centerline of both roadway approaches shall coincide with the crossing alignment centerline for a minimum distance of 50 feet from each bank of the waterway being crossed. If physical or right-of-way restraints preclude the 50 feet minimum, a shorter distance may be provided. All fill materials associated with the roadway approach shall be limited to a maximum height of 2 feet above the existing flood plain elevation.

i. The approaches to the structure shall consist of stone pads meeting the following specifications:

1) Stone: VDOT #1
2) Minimum thickness: 6 inches
3) Minimum width: equal to the width of the structure

j. A water diverting structure such as a swale shall be constructed (across the roadway on both roadway approaches) 50 feet (maximum) on either side of the waterway crossing. This will prevent roadway surface runoff from directly entering the waterway. The 50 feet is measured from the top of the waterway bank. Design criteria for this diverting structure shall be in accordance with Std. & Spec. 3.11, TEMPORARY RIGHT OF WAY DIVERSION or Std. & Spec. 3.09, TEMPORARY DIVERSION DIKE. If the roadway approach is constructed with a reverse grade away from the waterway, a separate diverting structure is not required.

TABLE 3.24-A
PIPE DIAMETER (INCHES) FOR STREAM CROSSINGS[a]

Drainage Area (Acres)	Average Slope of Watershed			
	1%	4%	8%	16%
1 - 25	24	24	30	30
26 - 50	24	30	36	36
51 - 100	30	36	42	48
101 - 150	30	42	48	48
151 - 200	36	42	48	54
301 - 350	42	48	60	60
351 - 400	42	54	60	60
451 - 500	42	54	60	72
501 - 550	48	60	60	72
551 - 600	48	60	60	72
601 - 640	48	60	72	72

[a] Note: Table is based on USDA-SCS Graphical Peak Discharge Method for 2-year frequency storm event, CN = 65; Rainfall depth = 3.5 inches (average for Virginia).

Source: Va. DSWC

Construction Specifications

1. Temporary Bridge Crossing (see Plate 3.24-1)

   a. Clearing and excavation of the stream bed and banks shall be kept to a minimum.

b. The temporary bridge structure shall be constructed at or above bank elevation to prevent the entrapment of floating materials and debris.

c. Abutments shall be placed parallel to and on stable banks.

d. Bridges shall be constructed to span the entire channel. If the channel width exceeds 8 feet (as measured from top-of-bank to top-of-bank), then a footing, pier or bridge support may be constructed within the waterway. One additional footing, pier or bridge support will be permitted for each additional 8-foot width of the channel. No footing, pier or bridge support, however, will be permitted within the channel for waterways which are less than 8 feet wide.

e. Stringers shall either be logs, sawn timber, prestressed concrete beams, metal beams, or other approved materials.

f. Decking materials shall be of sufficient strength to support the anticipated load. All decking members shall be placed perpendicular to the stringers, butted tightly, and securely fastened to the stringers. Decking materials must be butted tightly to prevent any soil material tracked onto the bridge from falling into the waterway below.

g. Run planking (optional) shall be securely fastened to the length of the span. One run plank shall be provided for each track of the equipment wheels. Although run planks are optional, they may be necessary to properly distribute loads.

h. Curbs or fenders may be installed along the outer sides of the deck. Curbs or fenders are an option which will provide additional safety.

i. Bridges shall be securely anchored at only one end using steel cable or chain. Anchoring at only one end will prevent channel obstruction in the event that floodwaters float the bridge. Acceptable anchors are large trees, large boulders, or driven steel anchors. Anchoring shall be sufficient to prevent the bridge from floating downstream and possibly causing an obstruction to the flow.

j. All areas disturbed during installation shall be stabilized within 7 calendar days of that disturbance in accordance with MS #1.

k. When the temporary bridge is no longer needed, all structures including abutments and other bridging materials should be removed immediately.

l. Final clean-up shall consist of removal of the temporary bridge from the waterway, protection of banks from erosion, and removal of all construction materials. All removed materials shall be stored outside flood plain of the stream. Removal of the bridge and clean-up of the area shall be accomplished without construction equipment working in the waterway channel.

2. Temporary Culvert Crossing

a. Clearing and excavation of the stream bed and banks shall be kept to a minimum.

b. The invert elevation of the culvert shall be installed on the natural streambed grade to minimize interference with fish migration.

c. Filter cloth shall be placed on the streambed and streambanks prior to placement of the pipe culvert(s) and aggregate. The filter cloth shall cover the streambed and extend a minimum of six inches and a maximum of one foot beyond the end of the culvert and bedding material. Filter cloth reduces settlement and improves crossing stability. See Std. & Spec. 3.19, RIPRAP, for required physical qualities of the filter cloth.

d. The culvert(s) shall extend a minimum of one foot beyond the upstream and downstream toe of the aggregate placed around the culvert. In no case shall the culvert exceed 40 feet in length.

e. The culvert(s) shall be covered with a minimum of one foot of aggregate. If multiple culverts are used, they shall be separated by at least 12 inches of compacted aggregate fill. At a minimum, the bedding and fill material used in the construction of the temporary access culvert crossings shall conform with the aggregate requirements cited in part "i" under "Temporary Culvert Crossing."

f. When the crossing has served its purpose, all structures including culverts, bedding and filter cloth materials shall be removed. Removal of the structure and clean-up of the area shall be accomplished without construction equipment working in the waterway channel.

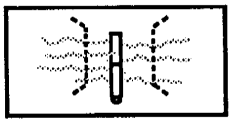
g. Upon removal of the structure, the stream shall immediately be shaped to its original cross-section and properly stabilized.

Maintenance

Both structures shall be inspected after every rainfall and at least once a week, whether it has rained or not, and all damages repaired immediately.

STD & SPEC 3.25

UTILITY STREAM CROSSING



USC

Definition

A strategy for crossing small waterways when in-stream utility construction is involved.

Purposes

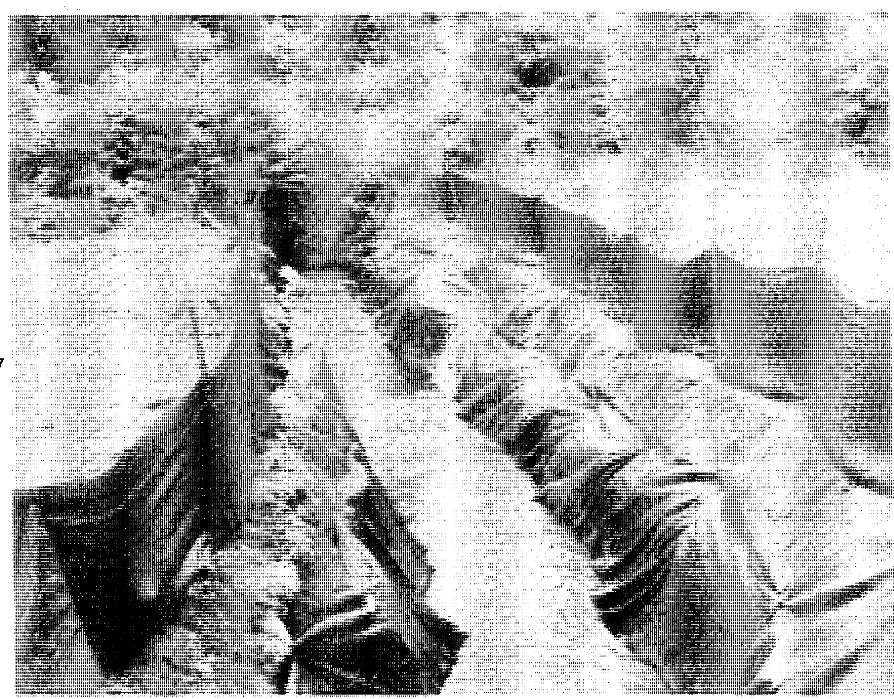
1. To help protect sediment from entering the stream from construction within approach areas.

2. To minimize the amount of disturbance within the stream itself.

Conditions Where Practice Applies

Generally applicable to flowing streams with drainage areas less than one square mile. Structures or methodology for crossing streams with larger drainage areas should be designed by methods which more accurately define the actual hydrologic and hydraulic parameters which will affect the functioning of the structure.

A *Diversion Channel* may be utilized to allow "work in the dry".



Planning Considerations

Utility construction, by virtue of its sprawling, linear nature, frequently crosses and impacts live streams. There is a potential for excessive sediment loss into a stream by both the disturbance of the approach areas and by the work with the stream-bed and banks.

It is often a difficult task to decide what type of control to use as a utility stream crossing. A method such as the "boring and jacking" of pipe below a streambed, which would prevent disturbance within the watercourse, is a preferred method if it is practical. However, in cases where in-stream work is unavoidable, consideration must be given to providing adequate mitigation of sediment loss while minimizing the amount of encroachment (MS #12) and time spent working in the channel. There is some "give and take" as far as the installation of controls - sometimes there is less damage to the environment created by providing substantial controls for the approach areas and refraining from installing extensive measures in the stream itself. However, when the installation of the utility line within streambed and banks will take an extended period of construction time, consideration should be given to substantial in-stream controls or stream diversion in order to prevent excessive sedimentation damage.

As a result of the difficulty in choosing the right method for a utility stream crossing, designers and plan reviewers should always make site visits of proposed crossing to ensure that the most appropriate method is chosen. The designer and plan reviewer should also be aware that such modifications are subject to other state and federal construction permits.

The following are several methods for dealing with utility stream crossings (with varying construction time and stream size scenarios) which allow for "work in the dry" to prevent excessive sedimentation damage. By no means are these methods all-inclusive. As with other control measures, site-specific design and innovative variations are encouraged.

Design Criteria (All methods)

1. The drainage area should be no greater than one square mile (640 acres).

2. All filter cloth used in the construction of the utility crossing must conform to physical requirements noted in Std. & Spec. 3.19, RIPRAP.

3. Water diverting structures should be used at all trenching and/or construction road approaches (50 feet on either side of the crossing) as per Std. & Spec. 3.24, VEHICULAR STREAM CROSSING.

4. Design criteria more specific to each particular crossing can be found in Plates 3.25-1 through 3.25-4.

Construction Specifications

1. Diversion Channel Crossing - Preferred method if construction will remain in area of stream for an extended period (longer than 72 hours) and site conditions (such as width of stream) make diversion practical.

   a. The diversion channel crossing must be operational before work is done in the stream (construction will be performed "in the dry").

   b. Minimum width of bottom shall be six feet or equal to bottom width of existing streambed, whichever is less. Refer to Plates 3.25-1 and 3.25-2.

   c. Maximum steepness of side slopes shall be 2:1. Depth and grade may be variable, dependent on site conditions, but shall be sufficient to ensure continuous flow of water in the diversion.

   d. There are three types of diversion channel linings which can be used, based upon expected velocity of bankfull flow. Refer to Plate 3.25-2 and the following table:

TABLE 3.25-A

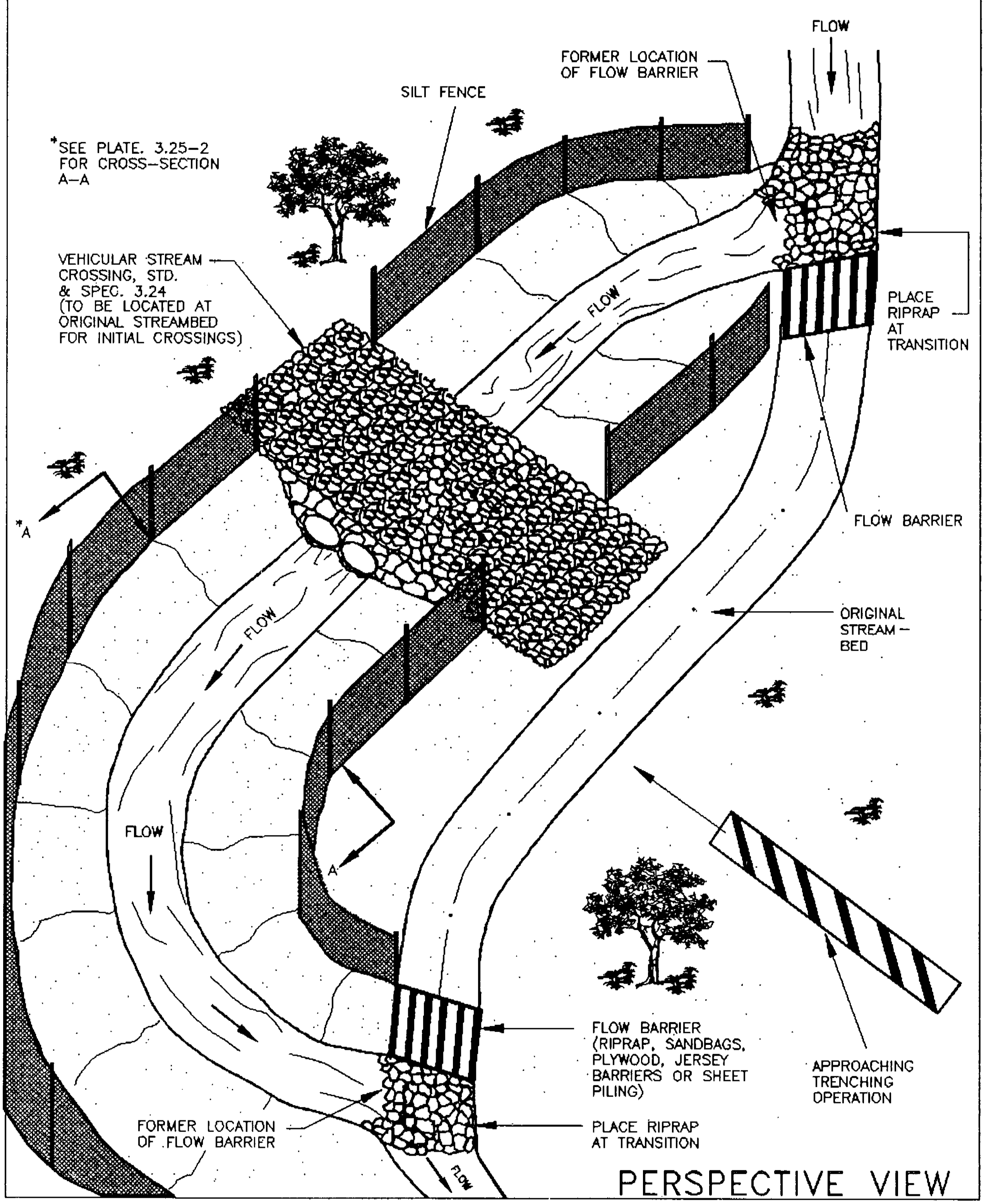
DIVERSION CHANNEL LININGS

Lining Material	Classification	Acceptable Velocity Range
Filter Cloth*, Polyethylene or Grass	TYPE A	0 - 2.5 f.p.s.
Filter Cloth*	TYPE B	2.5 - 9.0 f.p.s.
Class I Riprap and Filter Cloth*	TYPE C	9.0 - 13.0 f.p.s.

* Filter Cloth must meet the minimum physical requirements noted in Std. & Spec. 3.19, RIPRAP.

Source: VDOT Standard Sheets

DIVERSION CHANNEL CROSSING

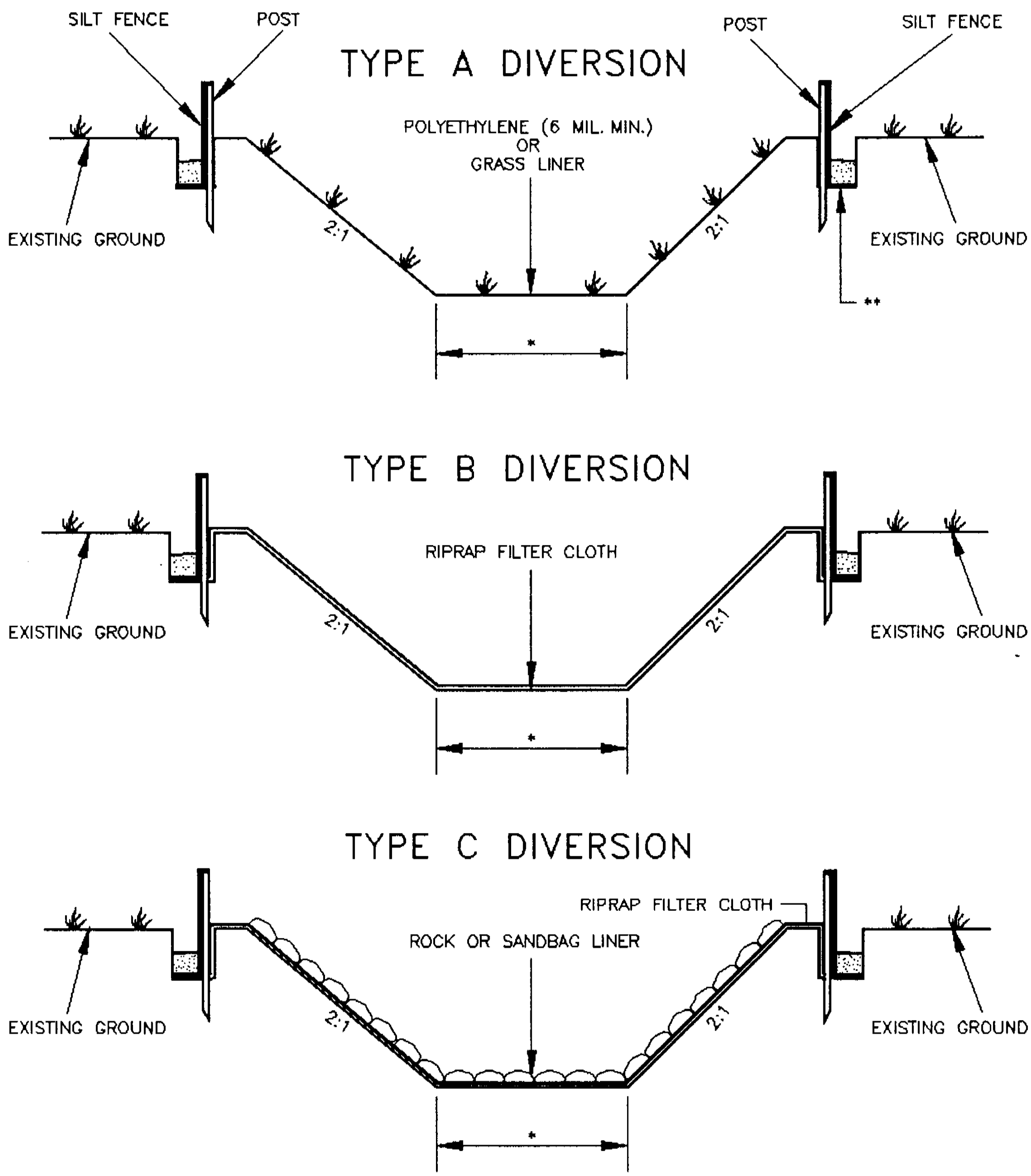


Source: Va. DSWC

Plate 3.25-1

DIVERSION CHANNEL CROSSING

ACCEPTABLE LININGS
(CROSS SECTION A-A OF PLATE 3.25-1)



* 6' MINIMUM OR WIDTH OF EXISTING STREAM WHICHEVER IS LESS

** ENTRENCH SILT FENCE AND FILTER CLOTH IN SAME TRENCH

Source: Adapted from VDOT Standard Sheets — Plate 3.25-2

e. Type A stream diversions may be seeded with a standard seed mix for the type of soils encountered and the time of year seed is sown. An average growth of two inches in height shall be achieved throughout the diversion with an 85% cover before water is turned through it.

f. Stream diversion liners shall be secured at the upstream and downstream sides with non-erodible weights such as riprap. These weights shall allow normal flow of the stream. Soil shall not be mixed in with stream diversion weights. Weights may also be needed along the stream diversion's length to secure liner.

g. Stream diversion liners should be overlapped when a single or continuous liner is not available or is impractical. Overlaps should be such that continuous flow of the steam is maintained. An upstream section should overlap a downstream section by a <u>minimum of 18 inches</u>. Overlaps along the cross-section should be made such that a liner is placed in the steam diversion bottom first and additional pieces of liner on the slopes overlap the bottom piece by a minimum of 18 inches.

h. Stream diversion liners shall be entrenched at the top of the diversion slopes (slopes breaks) along with a line of silt fence. Silt fence may be excluded if the diversion liner is extended to such a point that siltation of the stream will not occur. If silt fence is excluded, the diversion liner must be secured. Liners shall extend from slope break to slope break as shown in Plate 3.25-2.

i. Staples used in securing SOIL STABILIZATION BLANKETS AND MATTING (see Std. & Spec. 3.36) or non-erodible weights (riprap) shall be used as necessary to anchor stream diversion liners to the side slopes of the diversion. Wooden stakes should not be used on the diversion's bottom or side slopes.

j. Non-erodible materials such as riprap, jersey barriers, sandbags, plywood, or sheet piling, shall be used as flow barriers to divert the stream away from its original channel and to prevent or reduce water backup into a construction area.

k. The downstream flow barrier is to be removed prior to the upstream barrier when opening a stream diversion for the transport of water.

l. Streams should be rediverted upon completion of the utility crossing for which the diversion was built. Prior to rediversion, any materials (flow barrier) used to prevent water backup into the downstream end of the original streambed shall be removed. This material should not be placed in the downstream end of the diversion until after water has been rediverted to the original waterway. The stream should then be rediverted by removing all of the materials damming the upstream end of the original streambed and then placing it in the upstream end of the stream diversion. The diversion should be sealed off at the downstream end and then backfilled.

Once started, any work to relocate a stream shall not be discontinued until it is completed.

m. Stream should be rediverted only after backfilling and restabilization of original streambed and banks is completed. Restabilization shall consist of the installation of ungrouted riprap on all disturbed streambank areas (or on the area 6 feet on both sides of the centerline of its utility trench, whichever is greater) with slopes of 3:1 or greater. Refer to Std. & Spec. 3.19, RIPRAP, for installation requirements. For slopes of 3:1 or less, vegetative stabilization may be used, pending approval by the Plan-Approving Authority or inspection authority. Stabilization of its streambed and banks and the approach areas should occur immediately following the attainment of final grade.

n. Any dewatering discharge from this operation shall be placed into an approved DEWATERING STRUCTURE (see Std. & Spec. 3.26).

2. Flume Pipe Crossing - To be used when in-stream construction will last less than 72 hours and stream is narrow (less than 10 feet wide), making "cofferdam" construction impractical.

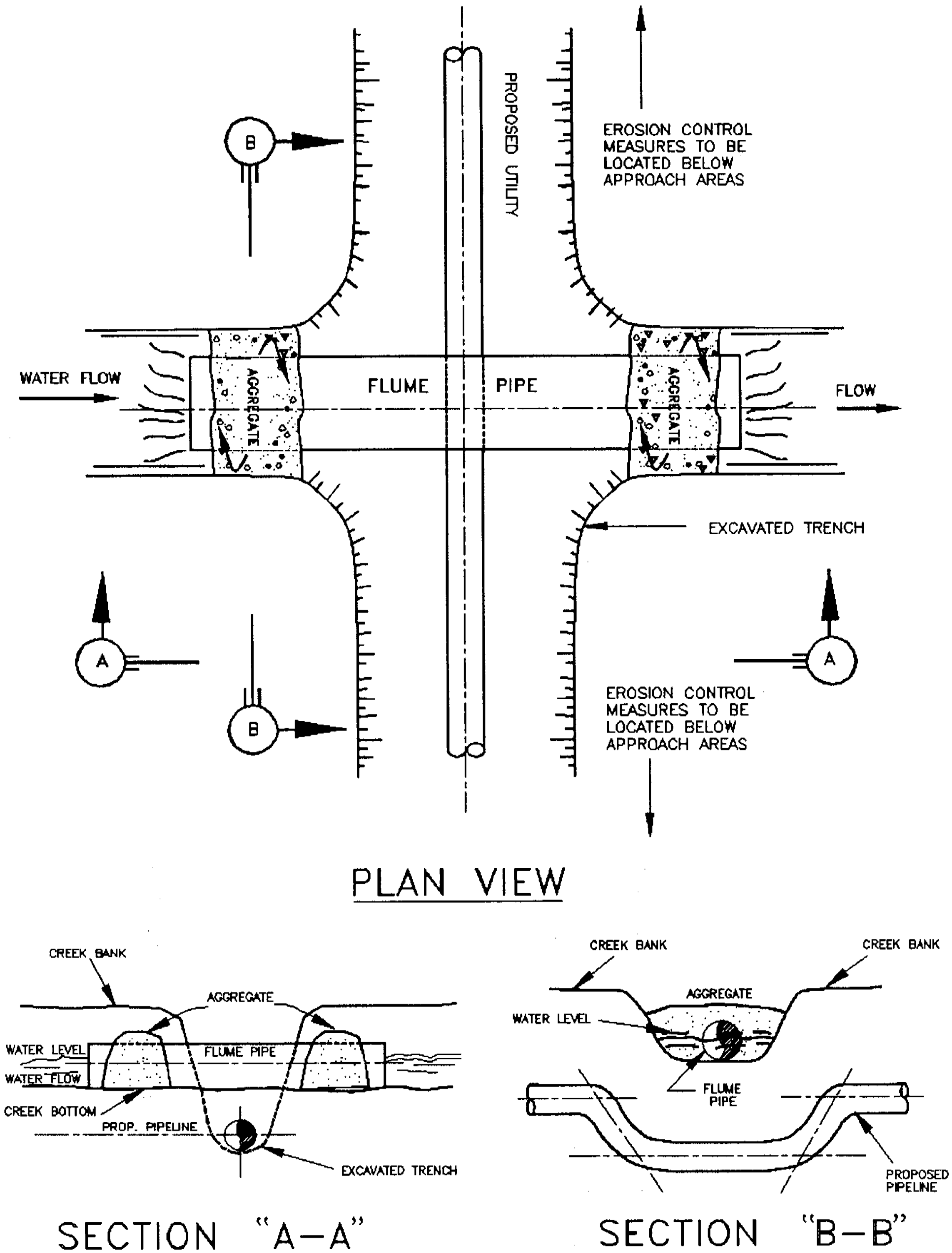
a. The flume pipe crossing must be made operational prior to the start of construction in the stream.

b. The materials used (culvert(s), stone and filter fabric) must meet the physical constraints of those used in VEHICULAR STREAM CROSSING, Std. & Spec. 3.24.

c. A large flume pipe (or culvert) of an adequate size to support normal water channel flow (see Table 3.24-A) shall then be installed in the stream bed across the proposed pipeline trench centerline. VDOT #1 Coarse Aggregate (minimum size) or riprap shall be placed close to each end of the flume pipe so as to dam off the creek forcing the water to flow through the flume pipe (see Plate 3.25-3).

d. The entrapped water can then be pumped from the creek within the dammed-off area and in the proposed trench centerline into an approved DEWATERING STRUCTURE (see Std. & Spec. 3.26). The trench can then be dug under the flume pipe. The pipe sections will then be installed to the proper depth under the flume pipe. After pipe sections are installed, the ditch will be backfilled and restabilization shall be carried out.

FLUME PIPE CROSSING



Source: Va. DSWC

Plate 3.25-3

e. Restabilization shall consist of the installation of ungrouted riprap on all disturbed streambank areas (or on the area 6 feet on both sides of the centerline of the utility trench, whichever is greater) with slopes of 3:1 or greater. Refer to Std. & Spec. 3.19, **RIPRAP**, for installation requirements. For slopes of 3:1 or less, vegetative stabilization may be used, pending approval by the Plan-Approving Authority or inspection authority. Stabilization of its streambed and banks and the approach areas should occur immediately following the attainment of final grade.

f. After completion of backfilling operation and restoration of stream/creek banks and leveling of stream bed, the flume pipe can then be removed. The gravel can be removed or spread in the stream bed depending on permit requirements. Sediment control in approach areas shall not be removed until all construction is completed in stream/creek crossing area. All ground contours shall be returned to their original condition.

3. Cofferdam Utility Crossing - To be used when stream diversion is not practical and stream is wide enough (10 feet or wider) to make cofferdam installation practical.

a. Construction is to be performed in low flow periods.

b. Crossing shall be accomplished in a manner that will not prohibit the flow of the stream. (See Plate 3.25-4).

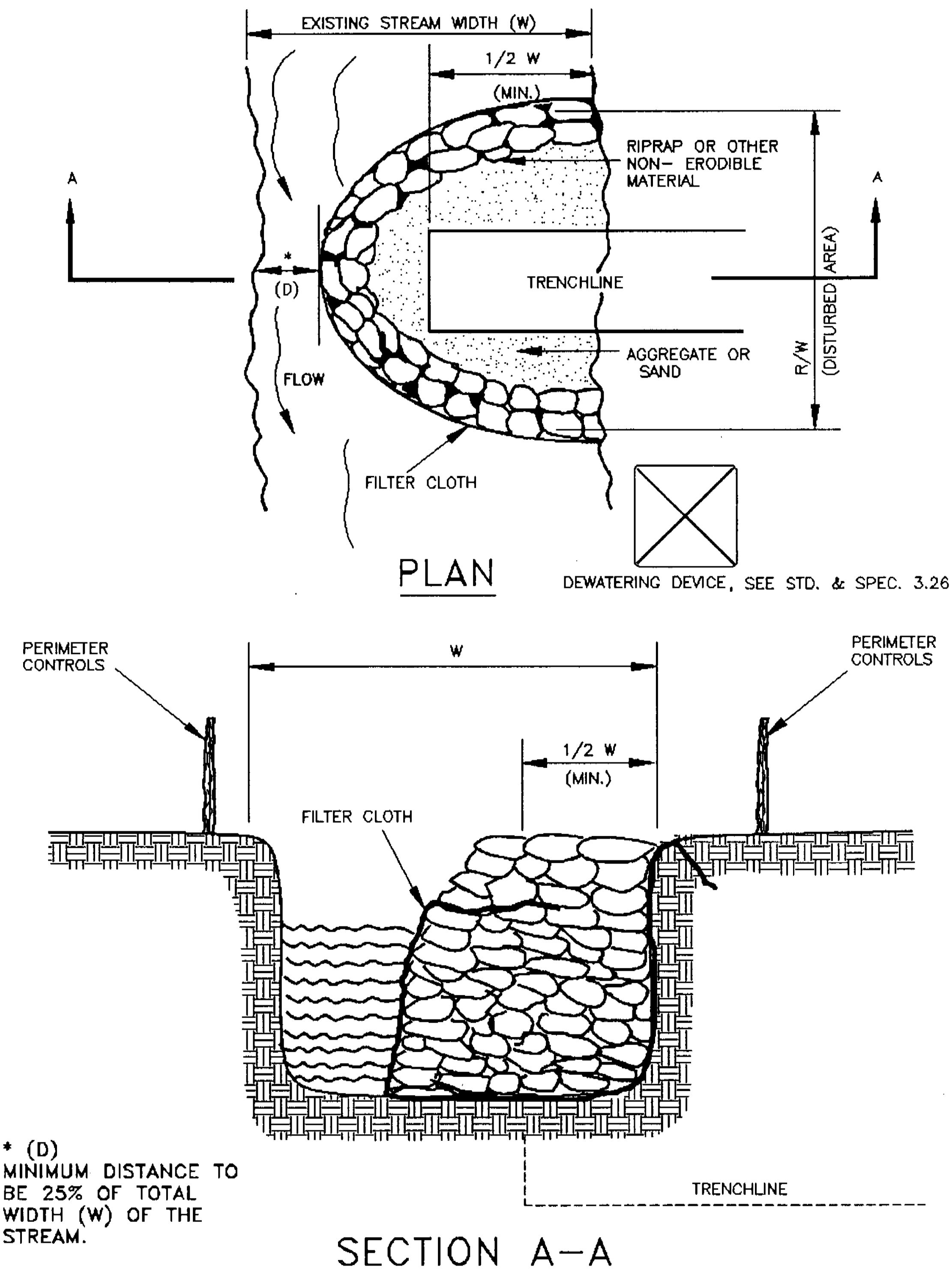
c. As with all utility line crossings, approach areas must be controlled with perimeter measures such as silt fence or straw bales.

d. Remove large rocks, woody vegetation, or other material from the streambed and banks that may get in the way of placing the riprap, sandbags, sheet metal, or wood planks or installing the utility pipe or line.

e. Form a cofferdam by placing the riprap (or other non-erodible materials) in a semicircle along the side of the stream in which the utility installation will begin. It must be surrounded and underlain with filter cloth as shown in Plate 3.25-4. The height of and area within the dam will depend upon the size of the work area and the amount of steam flow. Stack materials as high as will be necessary to keep water from overtopping the dam and flooding the work area. When the stream flow is successfully diverted by the cofferdam, dewater the work area and stabilize it with aggregate (VDOT #57 or #68 Coarse Aggregate) or sand. Make sure to discharge the water into a sediment trapping device (see DEWATERING STRUCTURE, Std. & Spec. 3.26).

g. Install the utility pipe or line in half the streambed as noted in Plate 3.25-4. Remove the riprap or other materials and begin placing them on the other side of the stream.

COFFERDAM CROSSING



* (D)
MINIMUM DISTANCE TO BE 25% OF TOTAL WIDTH (W) OF THE STREAM.

Source: Va. DSWC

Plate 3.25-4

h. Restabilization shall consist of the installation of ungrouted riprap on all disturbed streambank areas (or on the area 6 feet on both sides of the centerline of its utility trench, whichever is greater) with slopes of 3:1 or greater. Refer to Std. & Spec. 3.19, RIPRAP, for installation requirements. For slopes of 3:1 or less, vegetative stabilization may be used, pending approval by Plan-Approving Authority or inspection authority. Stabilization of its streambed and banks and the approach areas should occur <u>immediately</u> following the attainment of final grade.

<u>Maintenance</u>

Care must be taken to inspect any steam crossing area <u>at the end of each day to make sure that the construction materials are positioned securely</u>. This will ensure that the work area stays dry and that no construction materials float downstream.

STD & SPEC 3.26

DEWATERING STRUCTURE

DS

Definition

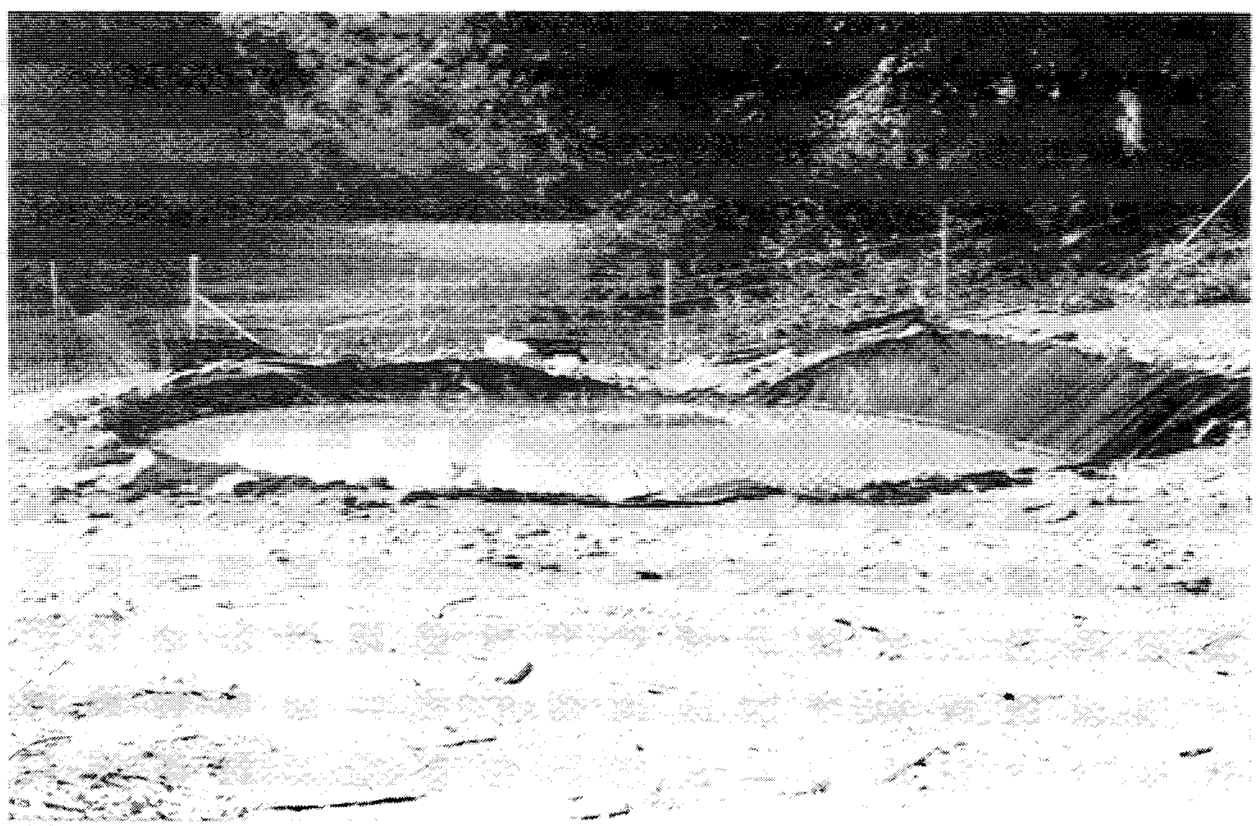
A temporary settling and filtering device for water which is discharged from dewatering activities.

Purpose

To filter sediment-laden water prior to the water being discharged off-site.

Conditions Where Practice Applies

Wherever sediment-laden water must be removed from a construction site by means of pumping.



Planning Considerations

Water which is pumped from a construction site usually contains a large amount of sediment. A dewatering structure is designed to remove the sediment before water is released off-site.

This practice includes several types of dewatering structures which have different applications dependent upon site conditions and types of operation. Other innovative techniques for accomplishing the same purpose are encouraged, but only after specific plans and details are submitted to and approved by the Plan-Approving Authority.

A dewatering structure may not be needed if there is a well- stabilized, vegetated area on-site to which water may be discharged. The area must be stabilized so that it can filter sediment and at the same time withstand the velocity of the discharged water without eroding. A minimum filtering length of <u>75 feet</u> must be available in order for such a method to be feasible.

Design Criteria

1. A dewatering structure must be sized (and operated) to allow pumped water to flow through the filtering device <u>without overtopping</u> the structure.

2. Material from any required excavation shall be stored in an area and protected in a manner that will prevent sediments from eroding and moving off-site.

3. An excavated basin (applicable to "Straw Bale/Silt Fence Pit") may be lined with filter fabric to help reduce scour and to prevent the inclusion of soil from within the structure.

4. Design criteria more specific to each particular dewatering device can be found in Plates 3.26-1 through 3.26-3.

Construction Specifications

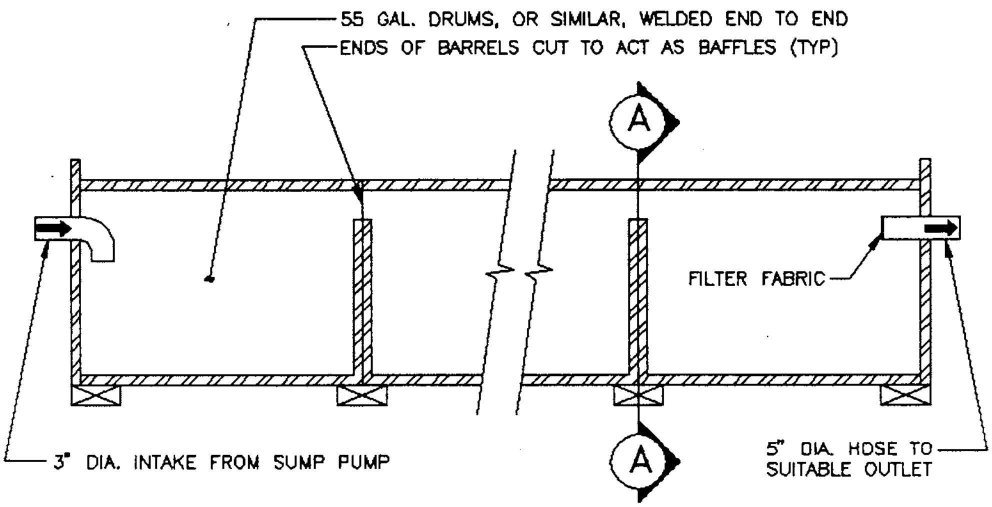
1. <u>Portable Sediment Tank</u> (see Plate 3.26-1)

    a. The structure may be constructed with steel drums, sturdy wood or other material suitable for handling the pressure exerted by the volume of water.

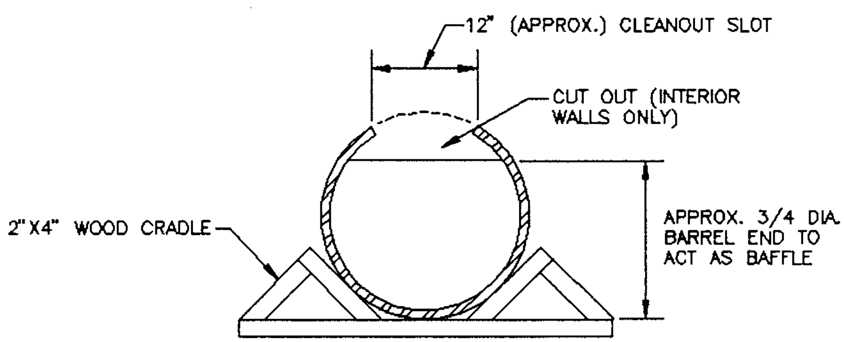
    b. Sediment tanks will have a minimum depth of two feet.

    c. The sediment tank shall be located for easy clean-out and disposal of the trapped sediment and to minimize the interference with construction activities.

PORTABLE SEDIMENT TANK



ELEVATION



CROSS-SECTION A-A

Source: USDA-SCS

Plate 3.26-1

d. The following formula shall be used to determine the storage volume of the sediment tank:

Pump discharge (g.p.m.) x 16 = *cubic feet of storage required*

e. Once the water level nears the top of the tank, the pump must be shut off while the tank drains and additional capacity is made available.

f. The tank shall be designed to allow for emergency flow over top of the tank.

g. Clean-out of the tank is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.

2. Filter Box (see Plate 3.26-2)

a. The box selected should be made of steel, sturdy wood or other materials suitable to handle the pressure requirements imposed by the volume of water. Fifty-five gallon drums welded top to bottom are normally readily available and, in most cases, will suffice.

b. Bottom of the box shall be made porous by drilling holes (or some other method).

c. VDOT #3 Coarse Aggregate shall be placed over the holes at a minimum depth of 12 inches (metal "hardware" cloth may need to be placed between the aggregate and the holes if holes are drilled larger than the majority of the stone).

d. As a result of the fast rate of flow of sediment-laden water through the aggregate, <u>the effluent must be directed over a well-vegetated strip of at least 50 feet after leaving the base of the filter box</u>.

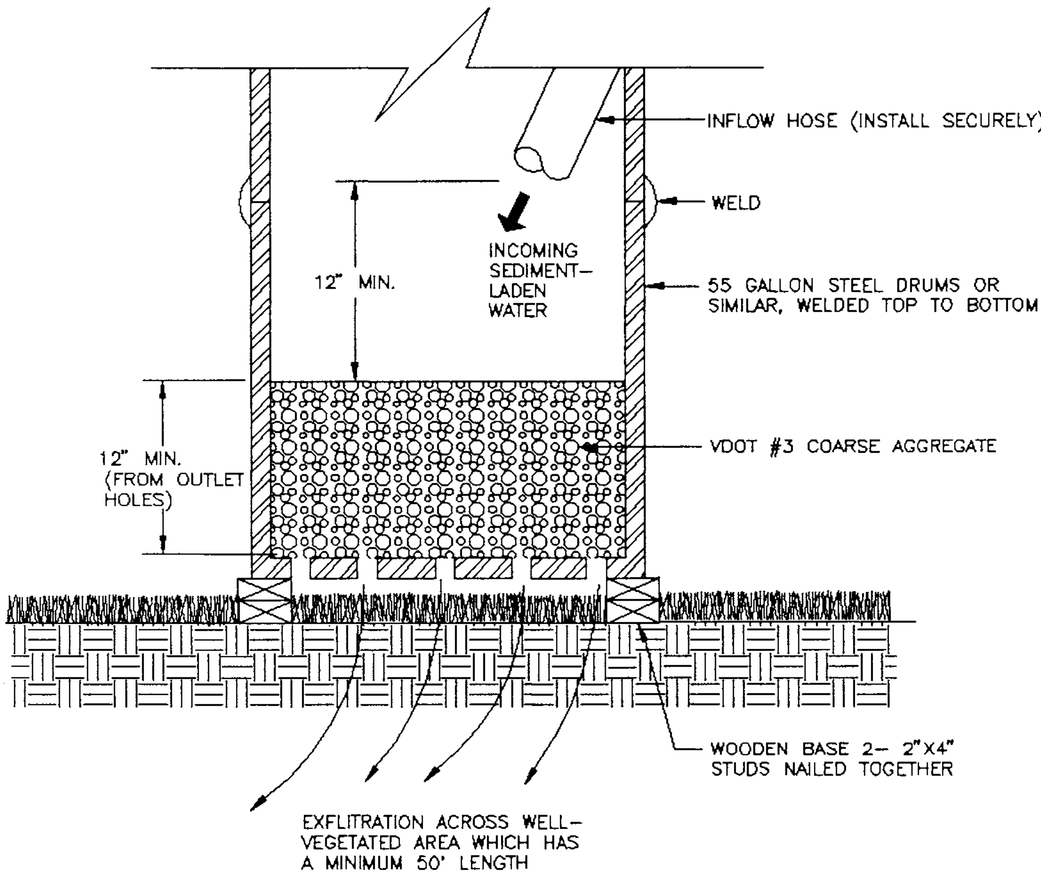
e. The box shall be sized as follows:

Pump discharge (g.p.m.) x 16 = *cubic feet of storage required*

f. Once the water level nears the top of the box, the pump must be shut off while the box drains and additional capacity is made available.

g. The box shall be designed/constructed to allow for emergency flow over the top of this box.

FILTER BOX



ELEVATION VIEW

Source: Va. DSWC

Plate 3.26-2

h. Clean-out of the box is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.

i. If the stone filter does become clogged with sediment so that it no longer adequately performs its function, the stones must be pulled away from the inlet, cleaned and replaced.

Note: Using a filter box only allows for minimal settling time for sediment particles; therefore, it should only be used when site conditions restrict the use of the other methods.

3. Straw Bale/Silt Fence Pit (see Plate 3.26-3)

a. Measure shall consist of straw bales, silt fence, a stone outlet (a combination of VDOT Class AI Riprap and VDOT #25 or #26 Aggregate) and a wet storage pit oriented as shown in Plate 3.26-3.

b. The structure must have a capacity which is dictated by the following formula:

Pump discharge (g.p.m.) x 16 = *cubic feet of storage required*

In calculating the capacity, one should include the volume available from the floor of the excavation to the crest of the stone weir.

c. In any case, the excavated area should be a minimum of 3 feet below the base of the perimeter measures (straw bales or silt fence).

d. The perimeter measures must be installed as per the guidelines found in Std. & Spec. 3.04, STRAW BALE BARRIER and Std. & Spec. 3.05, SILT FENCE.

e. Once the water level nears the crest of the stone weir (emergency overflow), the pump must be shut off while the structure drains down to the elevation of the wet storage.

f. The wet storage pit may be dewatered only after a minimum of 6 hours of sediment settling time. This effluent should be pumped across a well-vegetated area or through a silt fence prior to entering a watercourse.

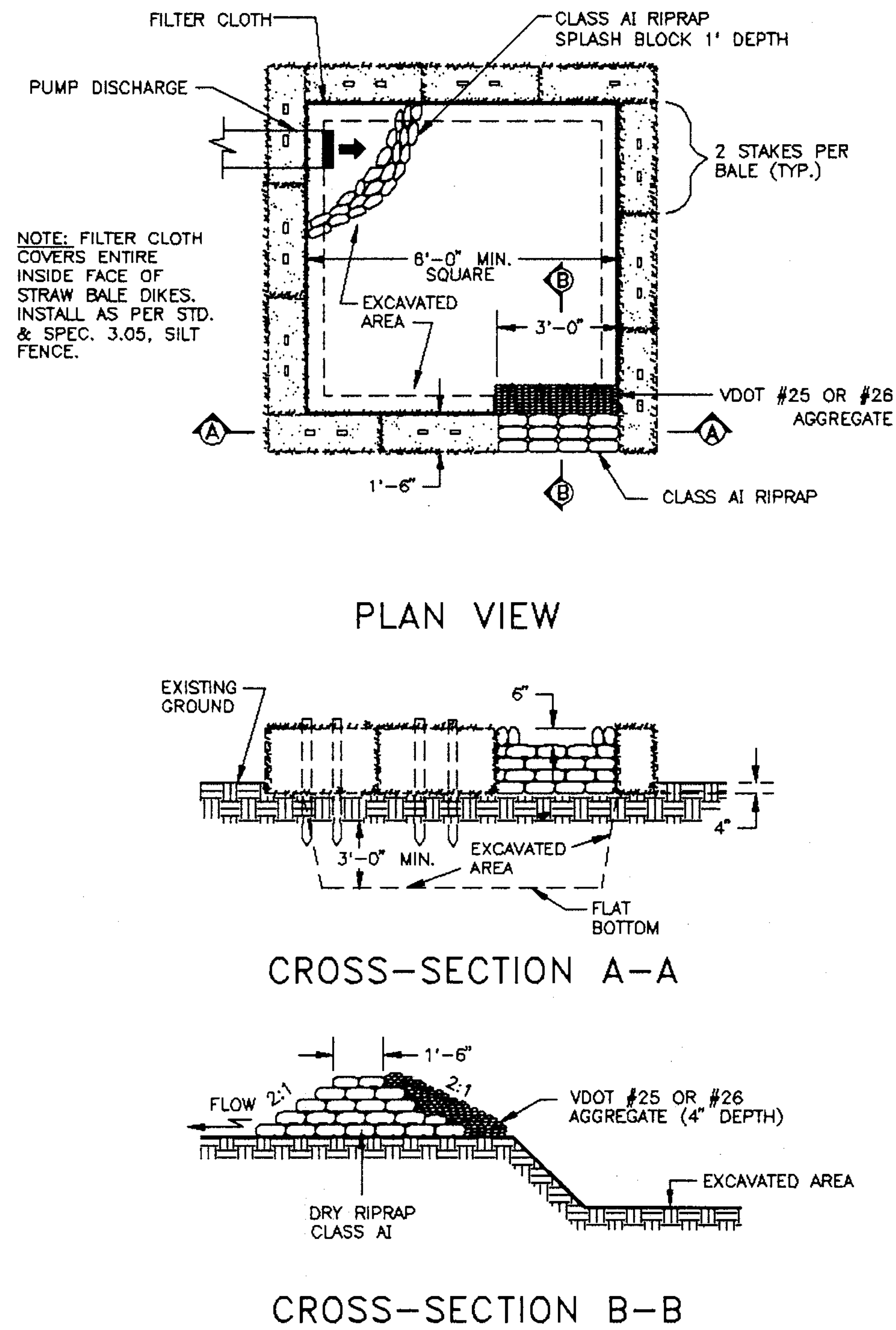
g. Once the wet storage area becomes filled to one-half of the excavated depth, accumulated sediment shall be removed and properly disposed of.

h. Once the device has been removed, ground contours will be returned to original condition.

Maintenance
(All dewatering structures)

1. The filtering devices must be inspected frequently and repaired or replaced once the sediment build-up prevents the structure from functioning as designed.

STRAW BALE/SILT FENCE PIT



Source: Va. DSWC

Plate 3.26-3

2. The accumulated sediment which is removed from a dewatering device must be spread on-site and stabilized or disposed of at an approved disposal site as per approved plan.

STD & SPEC 3.29

SURFACE ROUGHENING

SR

Definition

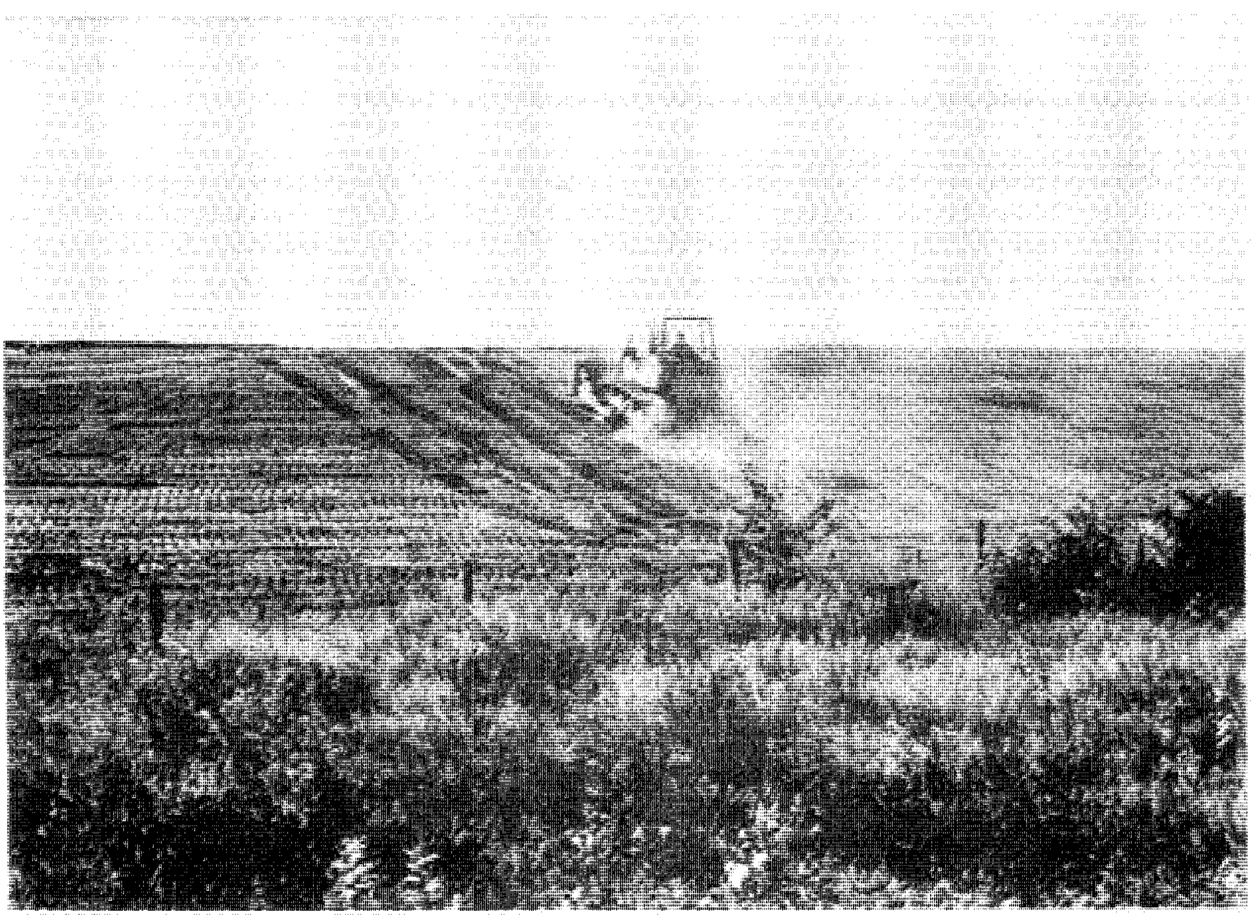
Providing a rough soil surface with horizontal depressions created by operating a tillage or other suitable implement on the contour, or by leaving slopes in a roughened condition by not fine-grading them.

Purposes

1. To aid in establishment of vegetative cover with seed.

2. To reduce runoff velocity and increase infiltration.

3. To reduce erosion and provide for sediment trapping.



Conditions Where Practice Applies

1. All slopes steeper than 3:1 require surface roughening, either stair-step grading, grooving, furrowing, or tracking if they are to be stabilized with vegetation.

2. Areas with grades less steep than 3:1 should have the soil surface lightly roughened and loose to a depth of 2 to 4 inches prior to seeding.

3. Areas which have been graded and will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place.

4. Slopes with a stable rock face do not require roughening or stabilization.

Planning Considerations

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but encourage water infiltration, speed the establishment of vegetation, and decrease runoff velocity.

Rough loose soil surfaces give lime, fertilizer and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

1. Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.

2. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established.

3. Areas which will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by discing, harrowing, raking, or seed-planting machinery operated on the contour.

4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as

effective as other forms of roughening, as the soil surface is severely compacted and runoff is increased.

Specifications

Cut Slope Applications For Areas Which Will Not Be Mowed

Cut slopes with a gradient steeper than 3:1 shall be stair-step graded or grooved (Plates 3.29-1 and 3.29-2).

1. Stair-step grading may be carried out on any material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.

   The ratio of the vertical cut distance to the horizontal distance shall be less than 1:1 and the horizontal portion of the "step" shall slope toward the vertical wall.

   Individual vertical cuts shall not be more than 30 inches on soft soil materials and not more than 40 inches in rocky materials.

2. Grooving consists of using machinery to create a series of ridges and depressions which run perpendicular to the slope (on the contour).

   Grooves may be made with any appropriate implement which can be safely operated on the slope and which will not cause undue compaction. Suggested implements include discs, tillers, spring harrows, and the teeth on a front-end loader bucket. Such grooves shall not be less than 3 inches deep nor further than 15 inches apart.

Fill Slope Applications For Areas Which Will Not Be Mowed

Fill slopes with a gradient steeper than 3:1 shall be grooved or allowed to remain rough as they are constructed. Method (1) or (2) below may be used.

1. Groove according to #2 above.

2. As lifts of the fill are constructed, soil and rock materials may be allowed to fall naturally onto the slope surface (see Plate 3.29-3).

Colluvial materials (soil deposits at the base of slopes or from old stream beds) shall not be used in fills as they flow when saturated.

At no time shall slopes be bladed or scraped to produce a smooth, hard surface.

Cuts, Fills, and Graded Areas Which Will Be Mowed

Mowed slopes should not be steeper than 3:1. Excessive roughness is undesirable where mowing is planned. These areas may be roughened with shallow grooves such as remain after tilling, discing, harrowing, raking, or use of a cultipacker-seeder. The final pass of any such tillage implement shall be on the contour (perpendicular to the slope).

Grooves formed by such implements shall be not less than 1-inch deep and not further than 12-inches apart. Fill slopes which are left rough as constructed may be smoothed with a dragline or pickchain to facilitate mowing.

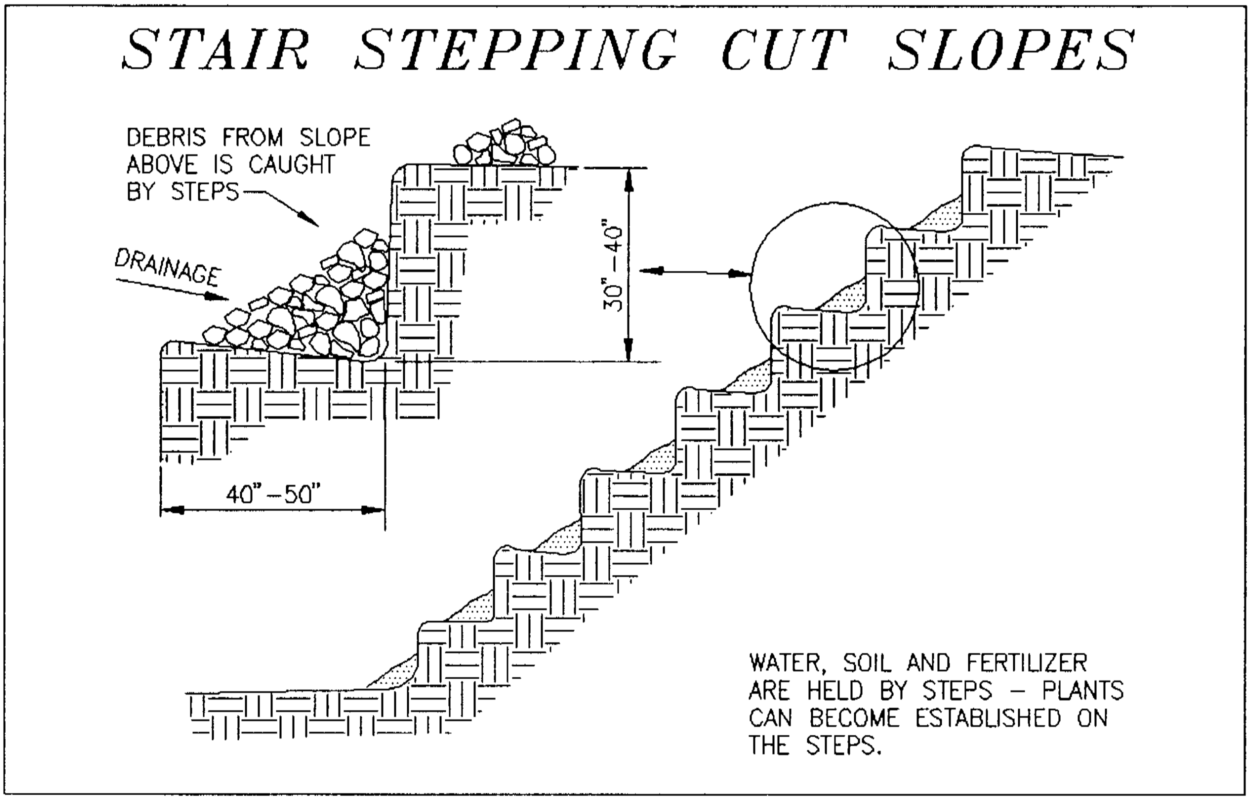
Roughening With Tracked Machinery (see Plate 3.29-4)

Roughening with tracked machinery on clayey soils is not recommended unless no alternatives are available. Undue compaction of surface soil results from this practice. Sandy soils do not compact severely, and may be tracked. In no case is tracking as effective as the other roughening methods described.

When tracking is the chosen surface roughening technique, it shall be done by operating tracked machinery up and down the slope to leave horizontal depressions in the soil. As few passes of the machinery should be made as possible to minimize compaction.

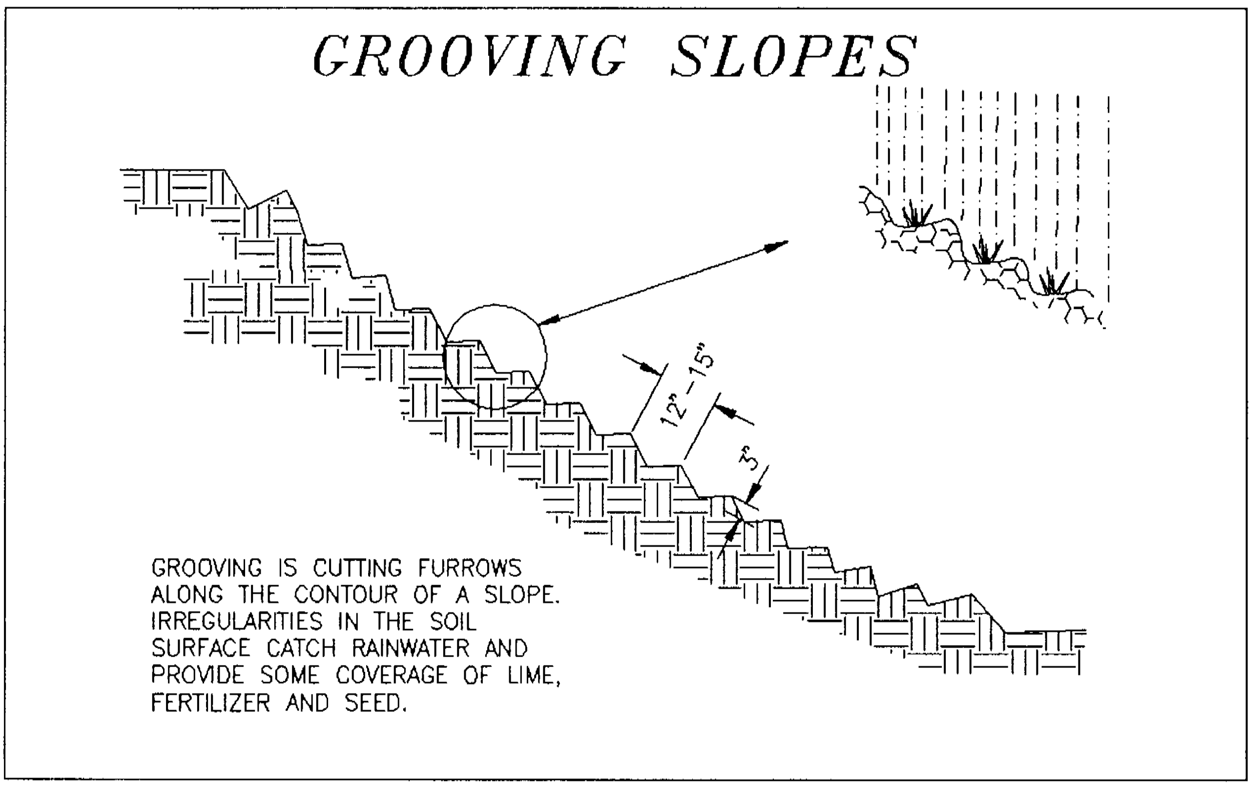
Seeding

Roughened areas shall be seeded and mulched as soon as possible to obtain optimum seed germination and seedling growth.



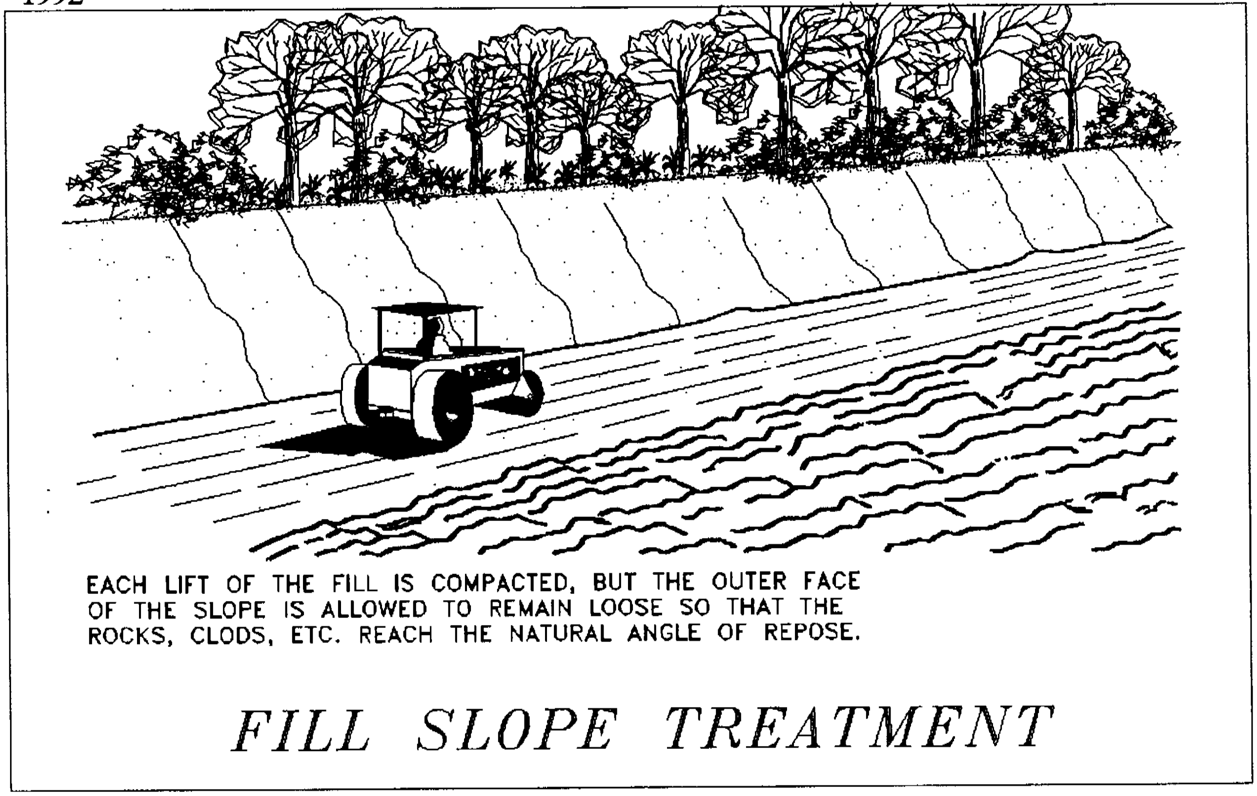
Source: Va. DSWC

Plate 3.29-1



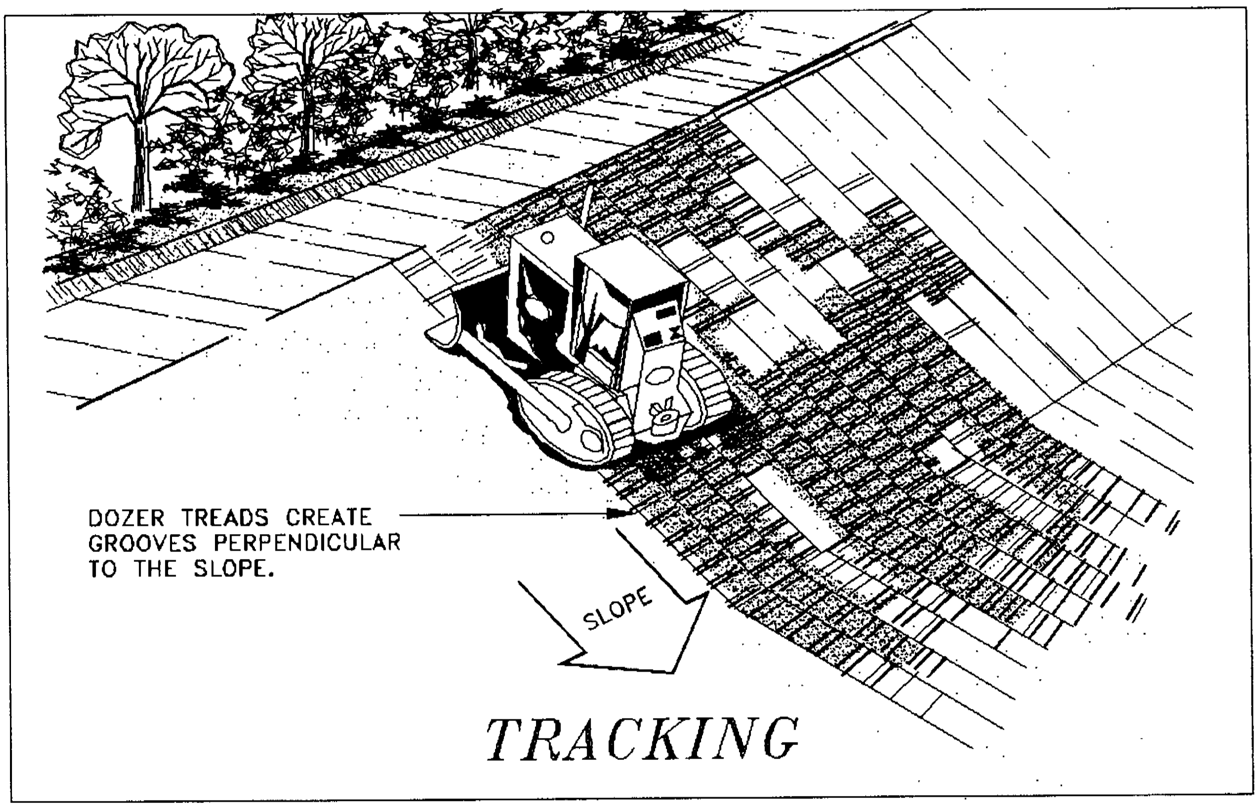
Source: Va. DSWC

Plate 3.29-2



Source: Va. DSWC

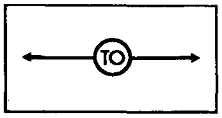
Plate 3.29-3



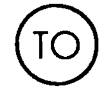
Source: Michigan Soil Erosion and Sedimentation Guide

Plate 3.29-4

STD & SPEC 3.30



TOPSOILING



Definition

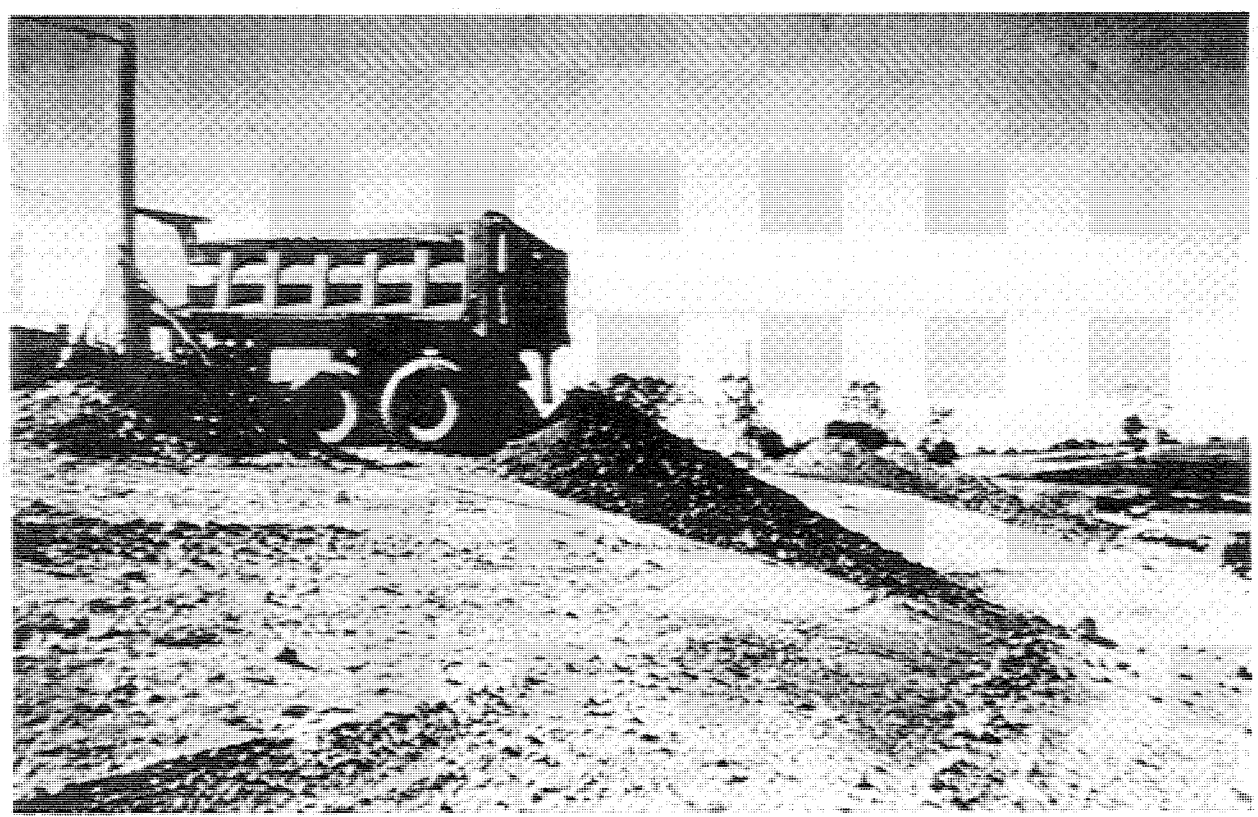
Methods of preserving and using the surface layer of undisturbed soil, often enriched in organic matter, in order to obtain a more desirable planting and growth medium.

Purpose

To provide a suitable growth medium for final site stabilization with vegetation.

Conditions Where Practice Applies

1. Where the preservation or importation of topsoil is determined to be the most effective method of providing a suitable growth medium.



2. Where the subsoil or existing soil presents the following problems:

   a. The texture, pH, or nutrient balance of the available soil cannot be modified by reasonable means to provide an adequate growth medium.

   b. The soil material is too shallow to provide an adequate root zone and to supply necessary moisture and nutrients for plant growth.

   c. The soil contains substances potentially toxic to plant growth.

3. Where high-quality turf is desirable to withstand intense use or meet aesthetic requirements.

4. Where ornamental plants will be established.

5. Only on slopes that are 2:1 or flatter unless other measures are taken to prevent erosion and sloughing.

Planning Considerations

Topsoil is the surface layer of the soil profile, generally characterized as being darker than the subsoil due to the presence of organic matter. It is the major zone of root development, carrying much of the nutrients available to plants, and supplying a large share of the water used by plants.

Although topsoil provides an excellent growth medium, there are disadvantages to its use. Stripping, stockpiling, and reapplying topsoil, or importing topsoil, may not always be cost-effective. Topsoiling can delay seeding or sodding operations, increasing the exposure time of denuded areas. Most topsoil contains weed seeds, and weeds may compete with desirable species.

Advantages of topsoil include its high organic matter content and friable consistence, water-holding capacity, and nutrient content.

In site planning, the option of topsoiling should be compared with that of preparing a seedbed in subsoil. The clay content of subsoils does provide high moisture availability and deter leaching of nutrients and, when properly limed and fertilized, subsoils may provide a good growth medium which is generally free of weed seeds. In many cases topsoiling may not be required for the establishment of less demanding, lower maintenance plant material. Topsoiling is strongly recommended where ornamental plants or high-maintenance turf will be grown. Topsoiling is a required procedure when establishing vegetation on shallow soils, soils containing potentially toxic materials, and soils of critically low pH (high acid) levels.

If topsoiling is to be done, the following items should be considered:

1. Whether an adequate volume of topsoil exists on the site. Topsoil will be spread at a compacted depth of 2 to 4 inches (depths closer to 4 inches are preferred).

2. Location of the topsoil stockpile so that it meets specifications and does not interfere with work on the site.

3. Allow sufficient time in scheduling for topsoil to be spread and bonded prior to seeding, sodding, or planting.

4. Care must be taken not to apply topsoil to subsoil if the two soils have contrasting textures. Clayey topsoil over sandy subsoil is a particularly poor combination, as water may creep along the junction between the soil layers, causing the topsoil to slough. Sandy topsoil over a clay subsoil is equally as likely to fail.

5. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. Topsoiling of steep slopes should be discouraged unless good bonding of soils can be achieved.

Specifications

Materials

Field exploration of the site shall be made to determine if there is sufficient surface soil of good quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam). It shall be free of debris, trash, stumps, rocks, roots, and noxious weeds, and shall give evidence of being able to support healthy vegetation. It shall contain no substance that is potentially toxic to plant growth.

All topsoil shall be tested by a recognized laboratory for the following criteria:

Organic matter content shall be not less than 1.5% by weight.

pH range shall be from 6.0-7.5. If pH is less than 6.0, lime shall be added in accordance with soil test results or in accordance with the recommendations of the vegetative establishment practice being used.

Soluble salts shall not exceed 500 ppm.

If additional off-site topsoil is needed, it must meet the standards stated above.

Stripping

Topsoil operations should not be performed when the soil is wet or frozen. Stripping shall be confined to the immediate construction area. A 4-to 6-inch stripping depth is common, but depth may vary depending on the particular soil. All perimeter dikes, basins, and other sediment controls shall be in place prior to stripping.

Stockpiling

Topsoil shall be stockpiled in such a manner that natural drainage is not obstructed and no off-site sediment damage shall result. Stabilize or protect stockpiles in accordance with MS #2.

Side slopes of the stockpile shall not exceed 2:1.

Perimeter controls must be placed around the stockpile immediately; seeding of stockpiles shall be completed within 7 days of the formation of the stockpile, in accordance with Std. & Spec. 3.31, TEMPORARY SEEDING if it is to remain dormant for longer than 30 days (refer to MS #1 and MS #2).

Site Preparation Prior to and Maintenance During Topsoiling

Before topsoiling, establish needed erosion and sediment control practices such as diversions, grade stabilization structures, berms, dikes, level spreaders, waterways, sediment basins, etc. These practices must be maintained during topsoiling.

Grading: Previously established grades on the areas to be topsoiled shall be maintained according to the approved plan.

Liming: Where the pH of the subsoil is 6.0 or less, or the soil is composed of heavy clays, agricultural limestone shall be spread in accordance with the soil test or the vegetative establishment practice being used.

Bonding: After the areas to be topsoiled have been brought to grade, and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by discing or scarifying to a depth of at least 2 inches to ensure bonding of the topsoil and subsoil.

Applying Topsoil

Topsoil shall not be placed while in a frozen or muddy condition, when topsoil or subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed sodding or seeding. The topsoil shall be uniformly distributed to a minimum compacted depth of 2 inches on 3:1 or steeper slopes and 4 inches on flatter slopes. (See Table 3.30-A to determine volume of topsoil required for application to various depths). Any irregularities in the surface, resulting from topsoiling or other operations, shall be corrected in order to prevent the formation of depressions or water pockets.

It is necessary to compact the topsoil enough to ensure good contact with the underlying soil and to obtain a level seedbed for the establishment of high maintenance turf. However, undue compaction is to be avoided as it increases runoff velocity and volume, and deters seed germination. Special consideration should be given to the types of equipment used to place topsoil in areas to receive fine turf. Avoid unnecessary compaction by heavy machinery whenever possible. In areas which are not going to be mowed, the surface should be left rough in accordance with SURFACE ROUGHENING (Std. & Spec. 3.29).

Soil Sterilants

No sod or seed shall be placed on soil which has been treated with soil sterilants until sufficient time has elapsed to permit dissipation of toxic materials.

TABLE 3.30-A

CUBIC YARDS OF TOPSOIL REQUIRED FOR APPLICATION TO VARIOUS DEPTHS

Depth (inches)	Per 1,000 Square Feet	Per Acre
1	3.1	134
2	6.2	268
3	9.3	403
4	12.4	537
5	15.5	672
6	18.6	806

Source: Va. DSWC

STD & SPEC 3.31

TEMPORARY SEEDING

TS

Definition

The establishment of a temporary vegetative cover on disturbed areas by seeding with appropriate rapidly growing annual plants.

Purposes

1. To reduce erosion and sedimentation by stabilizing disturbed areas that will not be brought to final grade for a period of more than ~~30~~ 14 days. RWE; DEQ-OTS 3-12-14

2. To reduce damage from sediment and runoff to downstream or off-site areas, and to provide protection to bare soils exposed during construction until permanent vegetation or other erosion control measures can be established.

Conditions Where Practice Applies

Where exposed soil surfaces will not be at final grade for more than 14 days. ~~are not to be fine-graded for periods longer than 30~~ days. Such areas include denuded areas, soil stockpiles, dikes, dams, sides of sediment basins, temporary roadbanks, etc. (see MS #1 and MS #2). A permanent vegetative cover shall be applied to areas that will be left dormant for a period of more than 1 year.

Planning Considerations

Sheet erosion, caused by the impact of rain on bare soil, is the source of most fine particles in sediment. To reduce this sediment load in runoff, the soil surface itself should be protected. The most efficient and economical means of controlling sheet and rill erosion is to establish vegetative cover. Annual plants which sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover. Temporary seeding is encouraged whenever possible to aid in "controlling" construction sites.

Temporary seeding also prevents costly maintenance operations on other erosion control systems. For example, sediment basin clean-outs will be reduced if the drainage area of the basin is seeded where grading and construction are not taking place. Perimeter dikes will be more effective if not choked with sediment.

Temporary seeding is essential to preserve the integrity of earthen structures used to control sediment, such as dikes, diversions, and the banks and dams of sediment basins.

Proper seedbed preparation and the use of quality seed are important in this practice just as in permanent seeding. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.

Specifications

Prior to seeding, install necessary erosion control practices such as dikes, waterways, and basins.

Plant Selection

Select plants appropriate to the season and site conditions from Tables 3.31-B and 3.31-C. Note that Table 3.31-B presents plants which can be used without extensive evaluation of site conditions; Table 3.31-C presents more in-depth information on the plant materials.

Seedbed Preparation

To control erosion on bare soil surfaces, plants must be able to germinate and grow. Seedbed preparation is essential.

1. Liming: An evaluation should be conducted to determine if lime is necessary for temporary seeding. In most soils, it takes up to 6 months for a pH adjustment to occur following the application of lime. Therefore, it may be difficult to justify the cost of liming a temporary site, especially when the soil will later be moved and regraded. The following table may be used to determine the actual need along with suggested application rates.

TABLE 3.31-A

LIMING REQUIREMENTS FOR TEMPORARY SITES

pH Test	Recommended Application of Agricultural Limestone
below 4.2	3 tons per acre
4.2 to 5.2	2 tons per acre
5.2 to 6	1 ton per acre

Source: Va. DSWC

2. Fertilizer: Shall be applied as 600 lbs./acre of 10-20-10 (14 lbs./1,000 sq. ft.) or equivalent nutrients. Lime and fertilizer shall be incorporated into the top 2 to 4 inches of the soil if possible.

3. Surface Roughening: If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted, or hardened, the soil surface shall be loosened by discing, raking, harrowing, or other acceptable means (see SURFACE ROUGHENING, Std. & Spec. 3.29).

4. Tracking: Tracking with bulldozer cleats is most effective on sandy soils. This practice often causes undue compaction of the soil surface, especially in clayey soils, and does not aid plant growth as effectively as other methods of surface roughening.

Seeding

Seed shall be evenly applied with a broadcast seeder, drill, cultipacker seeder or hydroseeder. Small grains shall be planted no more than 1½ inches deep. Small seeds, such as Kentucky Bluegrass, should be planted no more than 1/4 inch deep. Other Grasses and Legumes should be planted from 1/4 inch to 1/2 inch deep.

Mulching

1. Seedings made in fall for winter cover and during hot and dry summer months shall be mulched according to MULCHING, Std. & Spec. 3.35, except that hydromulches (fiber mulch) will not be considered adequate. Straw mulch should be used during these periods.

2. Temporary seedings made under favorable soil and site conditions during optimum spring and fall seeding dates may not require mulch.

Re-seeding

Areas which fail to establish vegetative cover adequate to prevent rill erosion will be re-seeded as soon as such areas are identified.

TABLE 3.31-B

ACCEPTABLE TEMPORARY SEEDING PLANT MATERIALS

"QUICK REFERENCE FOR ALL REGIONS"

Planting Dates	Species	Rate (lbs./acre)
Sept. 1 - Feb. 15	50/50 Mix of Annual Ryegrass (Lolium multi-florum) & Cereal (Winter) Rye (Secale cereale)	50 - 100
Feb. 16 - Apr. 30	Annual Ryegrass (Lolium multi-florum)	60 - 100
May 1 - Aug 31	German Millet (Setaria italica)	50

Source: Va. DSWC

TABLE 3.31-C

TEMPORARY SEEDING PLANT MATERIALS, SEEDING RATES, AND DATES

SPECIES	SEEDING RATE		NORTH[a]			SOUTH[b]			PLANT CHARACTERISTICS
	Acre	1000 ft^2	3/1 to 4/30	5/1 to 8/15	8/15 to 11/1	2/15 to 4/30	5/1 to 9/1	9/1 to 11/15	
OATS (<u>Avena</u> <u>sativa</u>)	3 bu. (up to 100 lbs., not less than 50 lbs.)	2 lbs.	X	-	-	X	-	-	Use spring varieties (e.g., Noble).
RYE[d] (<u>Secale</u> <u>cereale</u>)	2 bu. (up to 110 lbs., not less than 50 lbs.)	2.5 lbs.	X	-	X	X	-	X	Use for late fall seedings, winter cover. Tolerates cold and low moisture.
GERMAN MILLET (<u>Setaria</u> <u>italica</u>)	50 lbs.	approx. 1 lb.	-	X	-	-	X	-	Warm-season annual. Dies at first frost. May be added to summer mixes.
ANNUAL RYEGRASS[c] (<u>Lolium</u> <u>multi-florum</u>)	60 lbs.	1½ lbs.	X	-	X	X	-	X	May be added in mixes. Will mow out of most stands.
WEEPING LOVEGRASS (<u>Eragrostis</u> <u>curvula</u>)	15 lbs.	5½ ozs.	-	X	-	-	X	-	Warm-season perennial. May bunch. Tolerates hot, dry slopes and acid, infertile soils. May be added to mixes.
KOREAN LESPEDEZA[c] (<u>Lespedeza</u> <u>stipulacea</u>)	25 lbs.	approx. 1½ lbs.	X	X	-	X	X	-	Warm season annual legume. Tolerates acid soils. May be added to mixes.

[a] Northern Piedmont and Mountain region. See Plates 3.22-1 and 3.22-2.
[b] Southern Piedmont and Coastal Plain.
[c] May be used as a cover crop with spring seeding.
[d] May be used as a cover crop with fall seeding.
X May be planted between these dates.
\- May <u>not</u> be planted between these dates.

STD & SPEC 3.32

PERMANENT SEEDING

PS

Definition

The establishment of perennial vegetative cover on disturbed areas by planting seed.

Purposes

1. To reduce erosion and decrease sediment yield from disturbed areas.

2. To permanently stabilize disturbed areas in a manner that is economical, adaptable to site conditions, and allows selection of the most appropriate plant materials.

3. To improve wildlife habitat.

4. To enhance natural beauty.

Conditions Where Practice Applies

1. Disturbed areas where permanent, long-lived vegetative cover is needed to stabilize the soil.

2. Rough-graded areas which will not be brought to final grade for a year or more.

Planning Considerations

Vegetation controls erosion by reducing the velocity and the volume of overland flow and protecting the bare soil surface from raindrop impact.

Areas which must be stabilized after the land has been disturbed require vegetative cover. The most common and economical means of establishing this cover is by seeding grasses and legumes. Permanent vegetative covers must meet the requirements of Minimum Standard #3.

Advantages of seeding over other means of establishing plants include the small initial establishment cost, the wide variety of grasses and legumes available, low labor requirement, and ease of establishment in difficult areas.

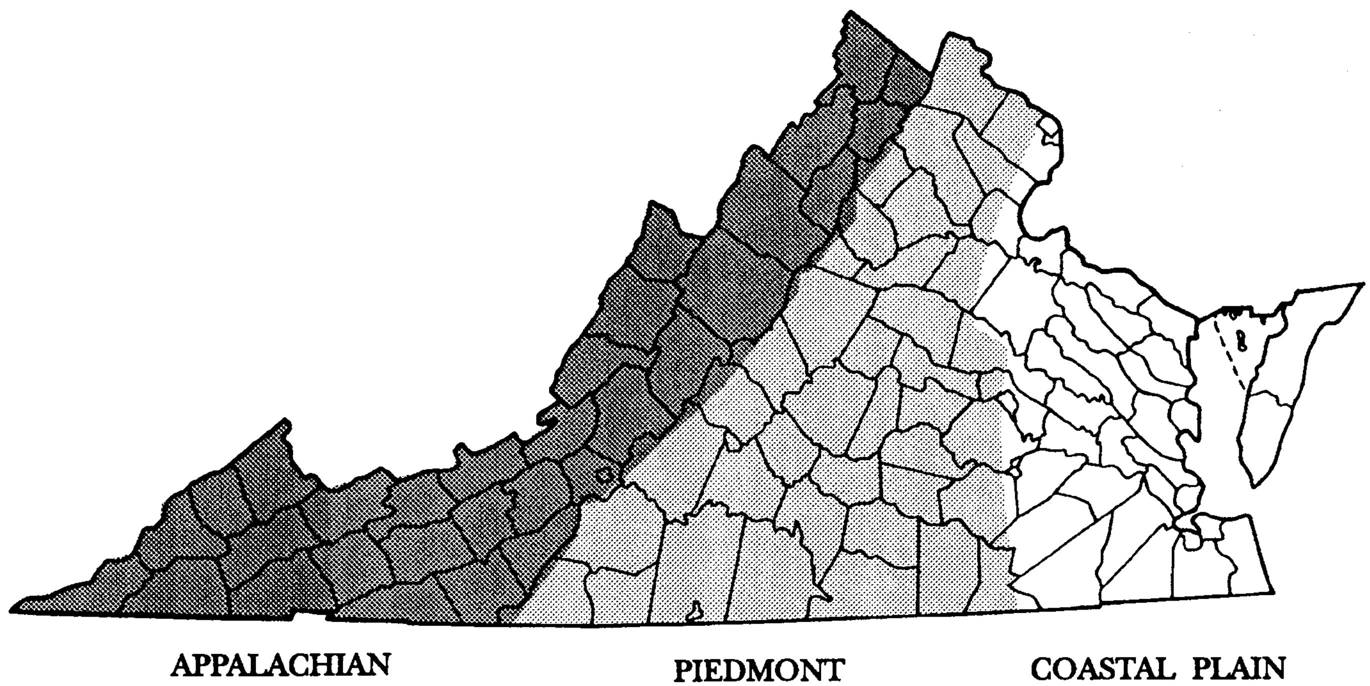
Disadvantages which must be dealt with are the potential for erosion during the establishment stage, a need to reseed areas that fail to establish, limited periods during the year suitable for seeding, the potential need for weed control during the establishment phase, and a need for water and appropriate climatic conditions during germination.

There are so many variables in plant growth that an end product cannot be guaranteed. Much can be done in the planning stages to increase the chances for successful seeding. Selection of the right plant materials for the site, good seedbed preparation, and conscientious maintenance are important.

SELECTING PLANT MATERIALS: The factors affecting plant growth are climate, soils, and topography. In Virginia, there are three major physiographic regions that reflect changes in soil and topography. In selecting appropriate plant materials, one should take into account the characteristics of the physiographic region in which the project is located (see Plate 3.32-1).

PHYSIOGRAPHIC REGIONS:

Coastal Plain - Soils on the Coastal Plain are deeply weathered, stratified deposits of sand and clay. They are generally acidic and low in plant nutrients. The sandy soils are hot and droughty in summer. This region receives more rain and is warmer than the other regions of the state. The land is fairly level, and many areas are poorly drained. Warm season grasses traditionally perform well in these areas.



PHYSIOGRAPHIC PROVINCES IN VIRGINIA

Source: Va. DSWC

Plate 3.32-1

Piedmont - Soils on the Piedmont plateau are highly variable. They tend to be shallow, with clayey subsoils. Piedmont soils are low in phosphorus. Soils derived from mica schist are highly erodible. Topography is rolling and hilly. The southern Piedmont has much the same climate as the Coastal Plain. Often referred to as the "transition zone" in planting. Contains areas that will support both warm or cool season grasses.

Appalachian and Blue Ridge Region - This region is divided into plateaus, mountains, and narrow valleys. Soils tend to be shallow and acid, and may erode rapidly on steep slopes. Shaley slopes are often unstable and droughty. This area is colder and drier than the rest of the State. The rugged topography makes plant establishment difficult. Cool season grasses are normally specified in this region.

SOILS: On the whole, soils in Virginia always require some nitrogen (N) fertilization to establish plants. Phosphorus (P) and potassium (K) are usually needed. Except for some small pockets of shallow limestone soils, lime is universally needed.

Soils can be modified with lime and fertilizer, but climate cannot be controlled. For this reason, the State has been divided into two major climatic regions, referred to as the Northern Piedmont and Mountain Region and the Southern Piedmont and Coastal Plain Region, for grass and legume selection (see map, Plate 3.32-2).

Microclimate, or localized climate conditions, can affect plant growth. A south-facing slope is drier and hotter than a north-facing slope, and may require drought-tolerant plants. Shaded areas require shade-tolerant plants; the windward side of a ridge will be drier than the leeward, etc.

LAND USE: A prime consideration in selecting which plants to establish is the intended use of the land. All of these uses - residential, industrial, commercial, recreational - can be separated into two major categories: high-maintenance and low-maintenance.

High-maintenance areas will be mowed frequently, limed and fertilized regularly, and will either receive intense use (e.g., athletics) or require maintaining to an aesthetic standard (home lawns). Grasses used for these situations must be fine-leaved and attractive in appearance, able to form tight sod, and be long-lived perennials. They must be well-adapted to the geographic area where they are planted, because constant mowing puts turf under great stress. Sites where high-maintenance vegetative cover is desirable include homes, industrial parks, schools, churches, athletic playing surfaces as well as some recreational areas.

Low-maintenance areas will be mowed infrequently or not at all; lime and fertilizer may not be applied on a regular basis; the areas will not be subjected to intense use, nor required to have a uniform appearance. These plants must be able to persist with little maintenance over long periods of time. Grass and legume mixtures are favored for these sites because legumes are capable of fixing nitrogen from the air for their own use, and the use of the plants around them. Such mixed stands are better able to withstand adverse conditions.

Sites that would be suitable for low-maintenance vegetation include steep slopes, stream or channel banks, some commercial properties, and "utility turf" areas such as roadbanks.

Seedbed Preparation - The soil on a disturbed site must be modified to provide an optimum environment for seed germination and seedling growth. The surface soil must be loose enough for water infiltration and root penetration. The pH (acidity and alkalinity) of the soil must be such that it is not toxic and nutrients are available, usually between pH 6.0-7.0. Sufficient nutrients (added as fertilizer) must be present. After seed is in place, it must be protected with a mulch to hold moisture and modify temperature extremes, and to prevent erosion while seedlings are growing.

The addition of lime is equally as important as applying fertilizer. Lime is best known as a pH, or acidity, modifier, but it also supplies calcium and magnesium which are plant nutrients. Its effect on pH makes other nutrients more available to the plant. It can also prevent aluminum toxicity by making aluminum less soluble in the soil. Many soils in Virginia are high in aluminum, which stunts the growth of plant roots.

MAINTENANCE: Even with careful, well-planned seeding operations, failures can occur. When it is clear that plants have not germinated on an area or have died, these areas must be reseeded immediately to prevent erosion damage. However, it is extremely important to determine for what reason germination did not take place and make any corrective action necessary prior to reseeding the area. Healthy vegetation is the most effective erosion control available.

Specifications

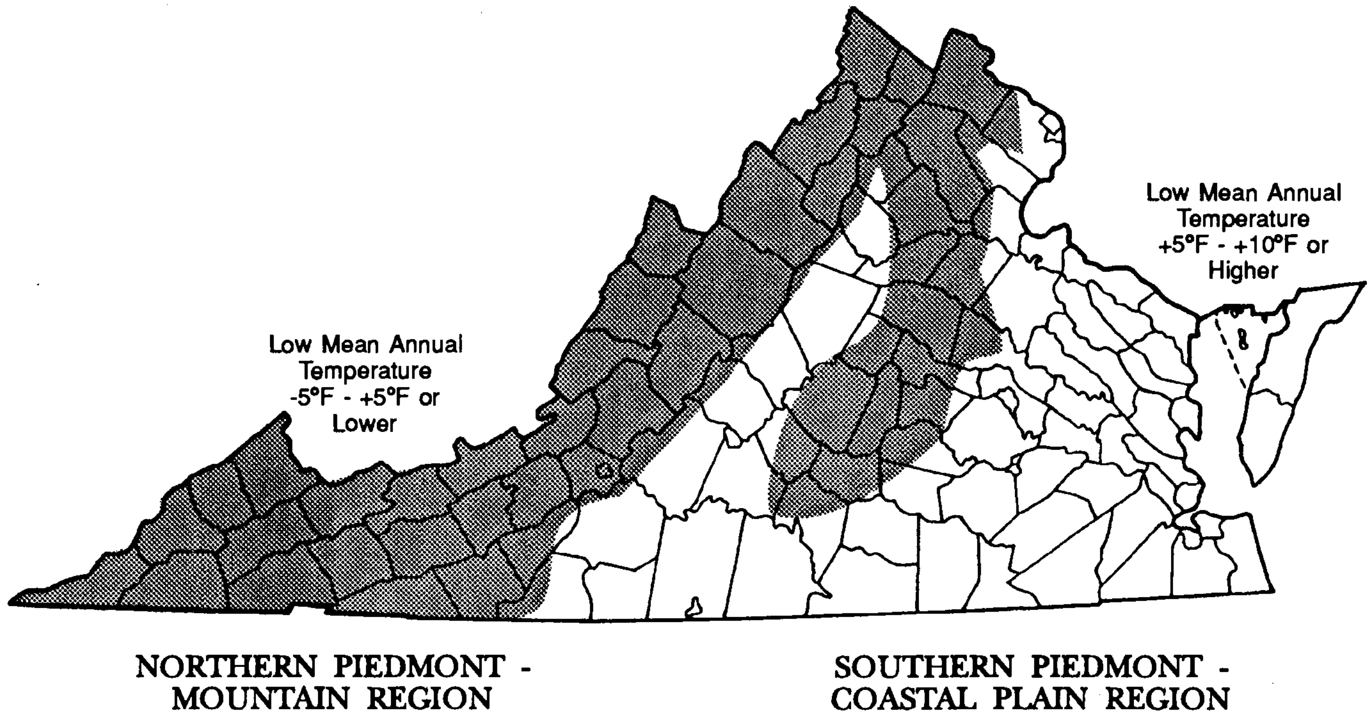
Selection of Plant Materials

1. Selection of plant materials is based on climate, topography, soils, land use, and planting season. To determine which plant materials are best adapted to a specific site, use Tables 3.32-A and 3.22-B which describe plant characteristics and list recommended varieties.

2. Appropriate seeding mixtures for various site conditions in Virginia are given in Tables 3.32-C, 3.32-D and 3.32-E. These mixtures are designed for general use, and are known to perform well on the sites described. Check Tables 3.32-A and 3.32-B for recommended varieties.

3. A more extensive description of plant materials (grasses and legumes), their usage and pictorial representation can be found in Appendix 3.32-c.

4. When using some varieties of turfgrasses, the Virginia Crop Improvement Association (VCIA) recommended turfgrass mixtures may also be used. Consumer protection programs have been devised to identify quality seed of the varieties recommended by the Virginia Cooperative Extension Service. These will bear a label indicating



PLANT HARDINESS ZONES IN VIRGINIA FOR GRASSES AND LEGUMES

Source: Adapted from Virginia Climate Advisory, 1979.

Plate 3.32-2

that they are approved by the Association. Mixtures may be designed for a specific physiographic region or based on intended use. Special consideration is given to plant characteristics, performance, etc.

TABLE 3.32-A
CHARACTERISTICS OF COMMONLY SELECTED GRASSES

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
TALL FESCUE (Festuca arundinacea)	P	C	5.5-6.2	10-14	60-85	F	F	M	SPD	225K	Low when used for erosion control; high when used in lawn	Better suited for erosion control and rough turf application.	Ky 31
TALL FESCUES (Improved)	P	C	5.5-6.2	10-14	60-85	F	G	M	SPD	220K	Responds well to high maintenance.	Excellent for lawn and fine turf.	See current VCIA list.
KENTUCKY BLUEGRASS (Poa pratense)	P	C	6.0-6.5	14	60-75	G	P	M	SPD	2.2m	Needs fertile soil, favorable moisture. Requires several years to become well established.	Excellent for fine turfs-takes traffic, mowing. Poor drought/heat tolerance.	See current VCIA list.
PERENNIAL RYEGRASS (Lolium perenne)	P	C	5.8-6.2	7-10	60-75	F	F	M-H	SPD	227K	Will tolerate traffic.	May be added to mixes. * Improved varieties will perform well all year.	See current VCIA list.

KEY

A = Annual P = Perennial C = Cool Season Plant W = Warm Season Plant G = Good F = Fair P = Poor VP = Very Poor H = High
M = Medium L = Low SPD = Somewhat Poorly Drained MPD = Moderately Poorly Drained PD = Poorly Drained VPD = Very Poorly Drained

TABLE 3.32-A (Continued)
CHARACTERISTICS OF COMMONLY SELECTED GRASSES

COMMON NAME (Botanical Name)		Life Cycle	Season	pH Range	Germination Time, In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
FINE FESCUES	HARD FESCUE (Festuca Longifolia)	P	C	5.0-6.2	10-14	60-80	VG	G	L	MWD	400K	Grows well in sun or shade and will tolerate infertile soils; improved disease resistance.	Exceeds all fine fescues in most tests. Excellent for low-maintenance situations.	Reliant, Spartan, Aurora
	CHEWINGS FESCUE	P	C	5.0-6.2	10-14	60-80	VG	G	L	MWD	400K	Tolerates shade, dry infertile soils.	Poor traffic tolerance, less thatch than other fine fescues.	Flyer
	RED FESCUE (Festuca Rubra)	P	C	5.0-6.2	10-14	60-80	VG	G	L	MWD	400K	Low to medium fertility requirements. Requires well-drained soil.	Spreads by rhizomes, tillers and stolons. Will not take traffic - very shade tolerant.	Long-fellow, Victory
REED CANARYGRASS (Phalaris arundinacea)		P	C	5.8-6.2	21	70-85	G	G	M-H	VPD	530K	Do not mow closely or often.	Conservation cover in wet areas.	No named varieties

KEY

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TABLE 3.32-A (Continued)
CHARACTERISTICS OF COMMONLY SELECTED GRASSES

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time, In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
REDTOP (Agrostis alba)	P	C	5.8-6.2	10	65-85	G	F	L	PD	5m	Will tolerate poor, infertile soils; deep rooted.	Does well in erosion control mixes - not for lawns.	No named varieties.
WEEPING LOVEGRASS (Evagrostis curvula)	P	W	4.5-6.2	14	65-85	F-P	G	L-M	SPD	1.5m	Low-fertility requirements; excellent drought tolerance.	Fast-growing, warm-season bunch grass. Excellent cover for erosion control.	No named varieties.
BERMUDAGRASS (Cynodon dactylon)	P	W	5.8-6.2	21	70-95	P	G	M-H	SPD	1.8m hulled	High nitrogen utilization, excellent drought tolerance. Some varieties adapted to western VA.	Common varieties used for erosion control. Hybrids used for fine turf.	See current VCIA list.
ORCHARDGRASS (Dactylis glomerata)	P	C	5.8-6.2	18	60-75	F	F	M	SPD	625K	Does best on well-drained, loamy soil.	Good pasture selection - may be grazed.	Virginia origin or Potomac

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TABLE 3.32-A (Continued)
CHARACTERISTICS OF COMMONLY SELECTED GRASSES

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
ANNUAL RYEGRASS (Lolium multiflorum)	A	C	5.8-6.2	7	60-70	G	P	M-H	SPD	227K	Will grow on most Virginia Soils. Do not use in fine-turf areas.	May be added into mixes or established alone as temporary cover in spring and fall.	No named varieties.
RYE (Secale cereale)	A	C	5.8-6.2	7	55-70	VG	G	L-M	SPD	18K	Will establish in most all Virginia soils. Do not use in fine-turf areas.	May be added into mixes or established alone for late fall/winter cover.	Abruzzi, Balboa
FOXTAIL MILLET (Setaria italica)	A	W	5.8-6.2	10	65-85	VP	G	M	MWD	220K	Establishes well during summer. Very low moisture requirements.	May be added to erosion-control mixes or established alone.	Common, German

KEY

A = Annual   P = Perennial   C = Cool Season Plant   W = Warm Season Plant   G = Good   F = Fair   P = Poor   VP = Very Poor   H = High
M = Medium   L = Low   SPD = Somewhat Poorly Drained   MPD = Moderately Poorly Drained   PD = Poorly Drained   VPD = Very Poorly Drained

TABLE 3.32-B
CHARACTERISTICS OF LEGUMES APPROPRIATE FOR EROSION CONTROL

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
CROWNVETCH (Coronilla varia)	P	C	6.0-6.5	14-21	70	G	VG	M	MWD	110K	Does best on well-drained soils. Minimum maintenance when established. May need phosphorus. Inoculation is essential.	Excellent for steep, rocky slopes. Produces colorful blooms in May/June. Slow to establish. Does best when seeded in spring.	Penngift Chemung Emerald
SERICEA LESPEDEZA (Lespedeza cuneata)	P	W	5.8-6.2	21-28	70-85	F	VG	L	MWD	335K	Grows in most well-drained soils. Low fertility requirements. Inoculation is essential.	Use hulled seed in spring; unhulled in fall. Very deep-rooted legume. Excellent choice for eastern Va.	Serecia Interstate
FLATPEA (Lathyrus silvestrus)	P	C	5.0-7.0	14-28	65-75	G	G	L	PD	15K	Needs lime and high phosphorus. Good shade tolerance.	Tolerates acidic and wetter soils better than other legumes.	Lathco
BIRDSFOOT TREFOIL (Lotus corniculatus)	P	C	6.0-6.5	7	65-70	G	F	M	SPD	375K	Inoculation is essential. Grows in medium-fertile, slightly acid soils.	Grows better on poorly drained soils than most legumes. Poor drought/ heat tolerance.	No named varieties.

KEY

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M = Medium L = Low SPD = Somewhat Poorly Drained MPD = Moderately Poorly Drained PD = Poorly Drained VPD = Very Poorly Drained

TABLE 3.32-B (Continued)
CHARACTERISTICS OF LEGUMES APPROPRIATE FOR EROSION CONTROL

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
ANNUAL LESPEDEZAS (Lespedeza striata, L. stipulacea)	A	W	5.8-6.2	14	70-85	F	VG	L	MWD	200K	Will grow on almost any well-drained soil.	Choose Kobe for southeastern Va.; needs almost no nitrogen to survive.	Kobe, Korean
RED CLOVER (Trifolium pratense)	P	C	6.0-6.5	7-14	70	G	F	M	SPD	275K	Needs high levels of phosphorus and potassium.	Acts as a biennial. Can be added to low-maintenance mixes.	Kenstar, Kenland
WHITE CLOVER (Trifolium repens)	P	C	6.0-6.5	10	70	G	P	M	PD	700K	Requires favorable moisture, fertile soils, high pH.	Spreads by soil surface stolons, white flowers.	Common, White Dutch

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TABLE 3.32-C
SITE SPECIFIC SEEDING MIXTURES FOR APPALACHIAN/MOUNTAIN AREA

	Total Lbs. Per Acre
Minimum Care Lawn	
- Commercial or Residential	200-250 lbs.
- Kentucky 31 or Turf-Type Tall Fescue	90-100%
- Improved Perennial Ryegrass *	0-10%
- Kentucky Bluegrass	0-10%
High-Maintenance Lawn	
Minimum of three (3) up to five (5) varieties of bluegrass from approved list for use in Virginia.	125 lbs.
General Slope (3:1 or less)	
- Kentucky 31 Fescue	128 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop **	20 lbs.
	150 lbs.
Low-Maintenance Slope (Steeper than 3:1)	
- Kentucky 31 Fescue	108 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop **	20 lbs.
- Crownvetch ***	20 lbs.
	150 lbs.

* Perennial Ryegrass will germinate faster and at lower soil temperatures than fescue, thereby providing cover and erosion resistance for seedbed.

** Use seasonal nurse crop in accordance with seeding dates as stated below:

March, April through May 15th	Annual Rye
May 16th through August 15th	Foxtail Millet
August 16th through September, October	Annual Rye
November through February	Winter Rye

*** If Flatpea is used, increase to 30 lbs./acre. All legume seed must be properly inoculated. Weeping Lovegrass may also be included in any slope or low-maintenance mixture during warmer seeding periods; add 10-20 lbs/acre in mixes.

TABLE 3.32-D
SITE SPECIFIC SEEDING MIXTURES FOR PIEDMONT AREA

	Total Lbs. Per Acre
Minimum Care Lawn	
- Commercial or Residential	175-200 lbs.
- Kentucky 31 or Turf-Type Tall Fescue	95-100%
- Improved Perennial Ryegrass	0-5%
- Kentucky Bluegrass	0-5%
High-Maintenance Lawn	200-250 lbs.
- Kentucky 31 or Turf-Type Tall Fescue	100%
General Slope (3:1 or less)	
- Kentucky 31 Fescue	128 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop *	20 lbs.
	150 lbs.
Low-Maintenance Slope (Steeper than 3:1)	
- Kentucky 31 Fescue	108 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop *	20 lbs.
- Crownvetch **	20 lbs.
	150 lbs.

* Use seasonal nurse crop in accordance with seeding dates as stated below:

February 16th through April	Annual Rye
May 1st through August 15th	Foxtail Millet
August 16th through October	Annual Rye
November through February 15th	Winter Rye

** Substitute Sericea lespedeza for Crownvetch east of Farmville, Va. (May through September use hulled Sericea, all other periods, use unhulled Sericea). If Flatpea is used in lieu of Crownvetch, increase rate to 30 lbs./acre. All legume seed must be properly inoculated. Weeping Lovegrass may be added to any slope or low-maintenance mix during warmer seeding periods; add 10-20 lbs./acre in mixes.

TABLE 3.32-D

SITE SPECIFIC SEEDING MIXTURES FOR COASTAL PLAIN AREA

	Total Lbs. Per Acre
Minimum Care Lawn	
- Commercial or Residential	
- Kentucky 31 or Turf-Type Tall Fescue	175-200 lbs.
or	
- Common Bermudagrass **	75 lbs.
High-Maintenance Lawn	
- Kentucky 31 or Turf-Type Tall Fescue	200-250 lbs.
or	
- Hybrid Bermudagrass (seed) **	40 lbs. (unhulled)
or	30 lbs. (hulled)
- Hybrid Bermudagrass (by other vegetative establishment method, see Std. & Spec. 3.34)	
General Slope (3:1 or less)	
- Kentucky 31 Fescue	128 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop *	20 lbs.
	150 lbs.
Low Maintenance Slope (Steeper than 3:1)	
- Kentucky 31 Tall Fescue	93-108 lbs.
- Common Bermudagrass **	0-15 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop *	20 lbs.
- Sericea Lespedeza **	20 lbs.
	150 lbs.

* Use seasonal nurse crop in accordance with seeding dates as stated below:

February, March through April . . . . Annual Rye
May 1st through August . . . . Foxtail Millet
September, October through November 15th . . . . . Annual Rye
November 16th through January . . . . Winter Rye

** May through October, use hulled seed. All other seeding periods, use unhulled seed. Weeping Lovegrass may be added to any slope or low-maintenance mix during warmer seeding periods; add 10-20 lbs./acre in mixes.

Seedbed Requirements

Vegetation should not be established on slopes that are unsuitable due to inappropriate soil texture, poor internal structure or internal drainage, volume of overland flow, or excessive steepness, until measures have been taken to correct these problems.

To maintain a good stand of vegetation, the soil must meet certain minimum requirements as a growth medium. The existing soil must have these characteristics:

1. Enough fine-grained material to maintain adequate moisture and nutrient supply.

2. Sufficient pore space to permit root penetration. A bulk density of 1.2 to 1.5 indicates that sufficient pore space is present. A fine granular or crumb-like structure is also favorable.

3. Sufficient depth of soil to provide an adequate root zone. The depth to rock or impermeable layers such as hardpans shall be 12 inches or more, except on slopes steeper than 2:1 where the addition of soil is not feasible.

4. A favorable pH range for plant growth. If the soil is so acidic that a pH range of 6.0-7.0 cannot be attained by addition of pH-modifying materials, then the soil is considered an unsuitable environment for plant roots and further soil modification would be required.

5. Freedom from toxic amounts of materials harmful to plant growth.

6. Freedom from excessive quantities of roots, branches, large stones, large clods of earth, or trash of any kind. Clods and stones may be left on slopes steeper than 3:1 if they do not significantly impede good seed soil contact.

If any of the above criteria cannot be met, i.e., if the existing soil is too coarse, dense, shallow, acidic, or contaminated to foster vegetation, then topsoil shall be applied in accordance with TOPSOILING, Std. & Spec. 3.30.

Necessary structural erosion and sediment control practices will be installed prior to seeding. Grading will be carried out according to the approved plan.

Surfaces will be roughened in accordance with SURFACE ROUGHENING, Std. & Spec. 3.29.

Soil Conditioners

In order to modify the texture, structure, or drainage characteristics of a soil, the following materials may be added to the soil:

1. Peat is a very costly conditioner, but works well. If added, it shall be sphagnum moss peat, hypnum moss peat, reed-sedge peat or peat humus, from fresh-water sources. Peat shall be shredded and conditioned in storage piles for at least six months after excavation.

2. Sand shall be clean and free of toxic materials. Sand modification is ineffective unless you are adding 80 to 90% sand on a volume basis. This is extremely difficult to do on-site. If this practice is considered, consult a professional authority to ensure that it is done properly.

3. Vermiculite shall be horticultural grade and free of toxic substances. It is an impractical modifier for larger acreage due to expense.

4. Raw manure is more commonly used in agricultural applications. However, when stored properly and allowed to compost, it will stabilize nitrogen and other nutrients. Manure, in its composted form, is a viable soil conditioner; however, its use should be based on site-specific recommendations offered by a professional in this field.

5. Thoroughly rotted sawdust shall have 6 pounds of nitrogen added to each cubic yard and shall be free of stones, sticks, and toxic substances.

6. The use of treated sewage sludge has benefitted from continuing advancements in its applications in the agricultural community. When composted, it offers an alternative soil amendment. Limitations include a potentially undesirable pH (because of lime added during the treatment process) and the possible presence of heavy metals. This practice should be thoroughly evaluated by a professional and be used in accordance with any local, state, and federal regulations.

Lime and Fertilizer

Lime and fertilizer needs should be determined by soil tests. Soil tests may be performed by the Cooperative Extension Service Soil Testing Laboratory at VPI&SU, or by a reputable commercial laboratory. Information concerning the State Soil Testing Laboratory is available from county extension agents. Reference Appendix 3.32-d for liming applications (in lbs.) needed to correct undesirable pH for various soil types.

Under unusual conditions where it is not possible to obtain a soil test, the following soil amendments will be applied:

Lime

Coastal Plain: 2 tons/acre pulverized agricultural grade limestone (90 lbs./1000 ft.^{2}).

Piedmont and Appalachian Region: 2 tons/acre pulverized agricultural grade limestone (90 lbs./1000 ft.^{2}).

Note: An agricultural grade of limestone should always be used.

Fertilizer

Mixed grasses and legumes: 1000 lbs./acre 10-20-10 or equivalent nutrients (23 lbs./1000 ft.^{2}).

Legume stands only: 1000 lbs./acre 5-20-10 (23 lbs./ 1000 ft.^{2}) is preferred; however, 1000 lbs./acre of 10-20-10 or equivalent may be used.

Grass stands only: 1000 lbs./acre 10-20-10 or equivalent nutrients, (23 lbs./1000 ft.^{2}).

Other fertilizer formulations, including slow-release sources of nitrogen (preferred from a water quality standpoint), may be used provided they can supply the same amounts and proportions of plant nutrients.

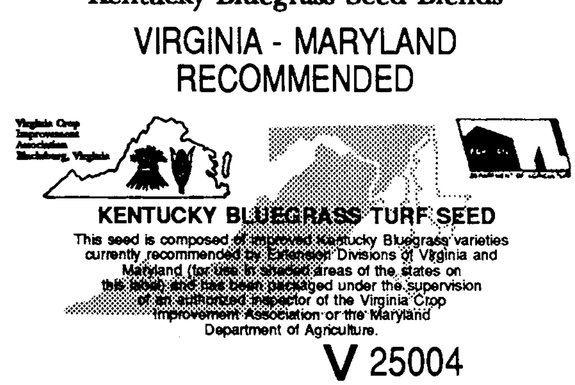
Incorporation - Lime and fertilizer shall be incorporated into the top 4-6 inches of the soil by discing or other means whenever possible. For erosion control, when applying lime and fertilizer with a hydroseeder, apply to a rough, loose surface.

Seeding

1. Certified seed will be used for all permanent seeding whenever possible. Certified seed is inspected by the Virginia Crop Improvement Association or the certifying agency in other states. The seed must meet published state standards and bear an official "Certified Seed" label (see Appendix 3.32-a).

Kentucky Bluegrass Seed Mixtures

Kentucky Bluegrass Seed Blends



2. Legume seed should be inoculated with the inoculant appropriate to the species. Seed of the Lespedezas, the Clovers and Crownvetch should be scarified to promote uniform germination.

3. Apply seed uniformly with a broadcast seeder, drill, culti-packer seeder, or hydroseeder on a firm, friable seedbed. Seeding depth should be 1/4 to 1/2 inch.

4. To avoid poor germination rates as a result of seed damage during hydroseeding, it is recommended that if a machinery breakdown of 30 minutes to 2 hours occurs, 50% more seed be added to the tank, based on the proportion of the slurry remaining in the tank. Beyond 2 hours, a full rate of new seed may be necessary.

   Often hydroseeding contractors prefer not to apply lime in their rigs as it is abrasive. In inaccessible areas, lime may have to be applied separately in pelletized or liquid form. Surface roughening is particularly important when hydroseeding, as a roughened slope will provide some natural coverage of lime, fertilizer and seed.

   Legume inoculants should be applied at five times the recommended rate when inoculant is included in the hydroseeder slurry.

Mulching

All permanent seeding must be mulched immediately upon completion of seed application. Refer to MULCHING, Std. & Spec. 3.35.

Maintenance of New Seedings

In general, a stand of vegetation cannot be determined to be fully established until it has been maintained for one full year after planting.

Irrigation: New seedings should be supplied with adequate moisture. Supply water as needed, especially late in the season, in abnormally hot or dry weather, or on adverse sites. Water application rates should be controlled to prevent excessive runoff. Inadequate amounts of water may be more harmful than no water.

Re-seeding: Inspect seeded areas for failure and make necessary repairs and re-seedings within the same season, if possible.

a. If vegetative cover is inadequate to prevent rill erosion, over-seed and fertilize in accordance with soil test results.

b. If a stand has less than 40% cover, re-evaluate choice of plant materials and quantities of lime and fertilizer. The soil must be tested to determine if acidity or nutrient imbalances are responsible. Re-establish the stand following seedbed preparation and seeding recommendations.

Fertilization: Cool season grasses should begin to be fertilized 90 days after planting to ensure proper stand and density. Warm season fertilization should begin at 30 days after planting.

Apply maintenance levels of fertilizer as determined by soil test. In the absence of a soil test, fertilization should be as follows:

Cool Season Grasses

4 lbs. nitrogen (N)

1 lb. phosphorus (P) Per 1000 ft.^{2} per year

2 lbs. potash (K)

Seventy-five percent of the total requirements should be applied between September 1 and December 31st. The balance should be applied during the remainder of the year. **More than 1 lb. of soluble nitrogen per 1000 ft.^{2} should not be applied at any one time.**

Warm Season Grasses

Apply 4-5 lbs. nitrogen (N) between May 1 and August 15th per 1000 ft.^{2} per year.

Phosphorus (P) and Potash (K) should only be applied according to soil test.

Note: The use of slow-release fertilizer formulations for maintenance of turf is encouraged to reduce the number of applications and the impact on groundwater.

Additional Information on the Successful Establishment of Grasses and Legumes

See Appendix 3.32-b for "helpful hints" in achieving high success rates in grass or legume plantings.

APPENDIX 3.32-a

SEED QUALITY CRITERIA

Where certified seed is not available, the minimum requirements for grass and legume seed used in vegetative establishment are as follows:

a. All tags on containers of seed shall be labeled to meet the requirements of the State Seed Law.

b. All seed shall be subject to re-testing by a recognized seed laboratory that employs a registered seed technologist or by a state seed lab.

c. All seed used shall have been tested within twelve (12) months.

d. Inoculant - the inoculant added to legume seed in the seed mixtures shall be a pure culture of nitrogen-fixing bacteria prepared for the species. Inoculants shall not be used later than the date indicated on the container. Twice the supplier's recommended rate of inoculant will be used on dry seedings; five times the recommended rate if hydroseeded.

e. The quality of the seed used shall be shown on the bag tags to conform to the guidelines in Table 3.32-E.

TABLE 3.32-E

QUALITY OF SEED*

	Minimum Seed Purity (%)	Minimum Germination (%)
Legumes		
Crownvetch	98	65**
Lespedeza, Korean	97	85**
Lespedeza, Sericea	98	85**
Grasses		
Bluegrass, Kentucky	97	85
Fescue, Tall (Improved, Turf-Type Cultivars)	98	85
Fescue, Tall (Ky-31)	97	85
Fescue, Red	98	85
Redtop	94	80
Reed Canarygrass	98	80
Perennial Ryegrass	98	90
Weeping Lovegrass	98	87
Annuals		
Annual Ryegrass	97	90
German Millet	98	85
Oats	98	80
Cereal Rye	98	85

* Seed containing prohibited or restricted noxious weeds should not be accepted. Seed should not contain in excess of 0.5% weed seed. To calculate percent pure, live seed, multiply germination times purity and divide by 100.

Example: Ky-31 Tall Fescue with a germination of 85 percent and a purity of 97 percent.

97 x 85 = 8245. 8245 ÷ 100 = 82.45 percent pure live seed.

** Includes "hard seed"

APPENDIX 3.32-b

KEYS TO SUCCESSFUL ESTABLISHMENT OF GRASSES AND LEGUMES

Planning

Where feasible, grading operations should be planned around optimal seeding dates for the particular region. The most effective times for establishing perennial grass in Virginia generally extend from March through May and from August through October. Outside these dates, the probability of failure is much higher. If the time of year is not suitable for seeding a permanent cover (perennial species), a temporary cover crop should be planted. Temporary seeding of annual species (small grains, ryegrasses or millets) often succeeds during periods of the year that are unsuitable for seeding permanent (perennial) species.

Variations in weather and local site conditions can modify the effects of regional climate on seeding success. For this reason, mixtures including both cool and warm season species are preferred for low-maintenance cover, particularly in the Coastal Plain. Such mixtures promote cover which can adapt to a range of conditions. Many of these mixtures are not desirable, however, for high quality lawns, where variation in texture of the turf is inappropriate. It is important to note that in Virginia the establishment of 100% warm season grasses in a high quality lawn is limited to the extreme eastern portions of the Coastal Plain.

Selection

Species selection should be considered early in the process of preparing an erosion and sediment control plan. A variety of vegetation can be established in Virginia due to the diversity in both soils and climate. However, for practical, economical stabilization and long-term protection of disturbed sites, species selection should be made judiciously.

Seasonality must be considered when selecting species. Grasses and legumes are usually classified as warm or cool season in reference to their season of growth. Cool season plants realize most of their growth during the spring and fall and are relatively inactive or dormant during the hot summer months. Therefore, fall is the most favorable time to plant them. Warm season plants "green-up" late in the spring, grow most actively during the summer, and go dormant at the time of the first frost in fall. Spring and early summer are preferred planting times for warm season plants.

Seed Mixtures

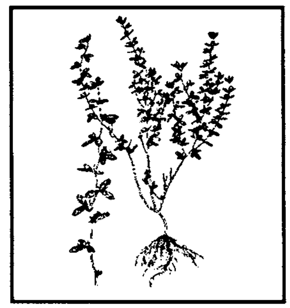
As previously noted, the establishment of high quality turf frequently involves planting one single species. However, in seedings for erosion control purposes, the inclusion of more than one species should always be considered. Mixtures need not be excessive in poundage or seed count. The addition of a quick-growing annual provides early protection and facilitates establishment of one or two perennials in a mix. More complex mixtures might include a quick-growing annual, one or two legumes and more than one perennial grass.

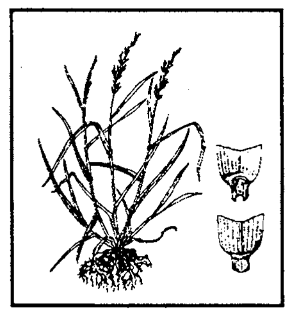
The addition of a "nurse" crop (quick-growing annuals added to permanent mixtures) is a sound practice for soil stabilization, particularly on difficult sites - those with steep slopes; poor, rocky, erosive soils; those seeded out the optimum seeding periods; or in any situation where the development of permanent cover is likely to be slow. The nurse crop germinates and grows rapidly, holding the soil until the slower-growing perennial seedlings become established.

APPENDIX 3.32-c

PLANT INFORMATION SHEETS

Contents:



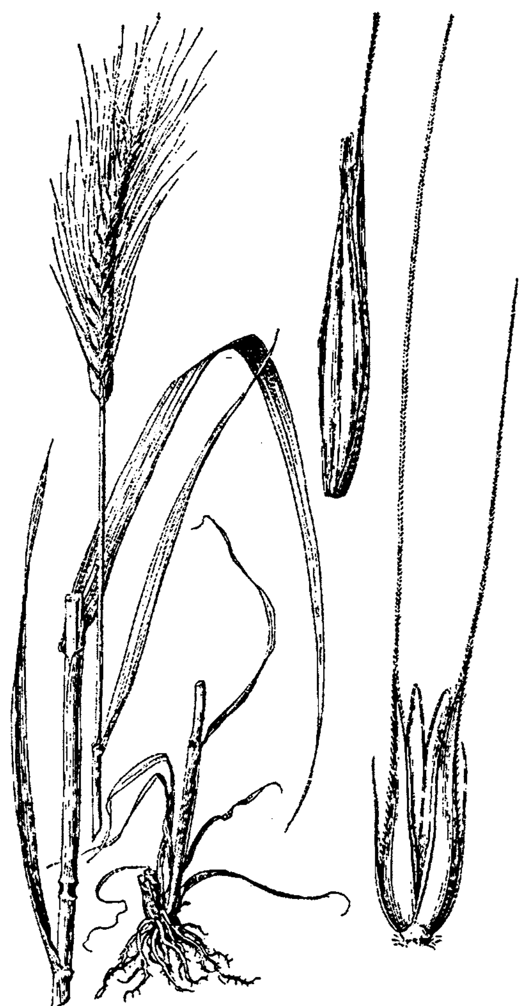


ANNUAL GRASSES AND GRAINS

Small grains are cool season annual grasses primarily grown for animal feed and human consumption. In Virginia, the grains used for soil stabilization are primarily Rye and Oats. Foxtail Millet, which is sometimes considered a small grain, is becoming a very popular and successful planting for soil stabilization.

1. Oats (Avenasativa): A cool season annual grass primarily grown for animal feed and human consumption, but also used for soil stabilization. Oats are seeded in early spring in the western part of the state (winter oats may be sown in the Coastal Plain). Seeding rates are 3 bushels (100 lbs.) per acre bare ground or 2-1/2 lbs. per 1000 square feet.

2. Rye (Secale cereale): Often referred to as Winter Rye because of its winter hardiness, Rye is the most common small grain used for soil stabilization. It is also the most productive grain on dry, infertile, acid or sandy soils. It may be seeded in the fall for winter ground cover. By maturing early, it offers less competition during the late spring period, a critical time in the establishment of perennial species. Rye grain germinates quickly and is tolerant of poor soils. Including Rye grain in fall-seeded mixtures is almost always advantageous, but it is particularly helpful on difficult and erodible soils, erodible slopes or when seeding is late. Rates up to 100 lbs. for bare ground. Overly thick stands of Rye grain will suppress the growth of perennial seedlings. Approximately 50 lbs. per acre is the maximum for this purpose and, where lush growth is



Rye (Secale cereale)

expected, that rate should either be cut in half, or Rye grain should be totally eliminated from the mixture.

3. Foxtail Millet (Setaria italica): A warm season annual grass which may be used for temporary cover. German Millet (variety commonly used in Virginia) germinates quickly and goes to seed quickly. These features make it an excellent companion grass for summer seedlings. It dies at first frost. Seeding rates are up to 50 lbs. per acre for temporary cover. Use 10 to 20 lbs. per acre in mixes.

4. Annual Rye (Lolium multiflorum): A cool season annual grass used for temporary cover or as a nurse grass to allow for germination of permanent stands. Most commonly used in mixes for erosion control. Performs well throughout the state in neutral to slightly acid soils. Rates up to 100 lbs. per acre for temporary cover. Use 10 to 20 lbs. per acre in mixes.

Foxtail Millet (Setaria italica)

Annual Rye (Lolium multiflorum)

ANNUAL LEGUMES

1. Annual Lespedezas (Lespedeza striata)

Uses: Pasture, hay, erosion control, soil improvement, wildlife food.

Description: Annual warm season legumes. Korean Lespedeza is larger and coarser than Common Lespedeza and grows to about 12 inches. Seed of Korean is shiny and black, while seed of Common is stippled. Kobe is the most desirable variety of Common Lespedeza.

Adaptation: Throughout Virginia. Optimum pH range is 6.0 to 6.5; will grow from 5.5 to 7.0. Will grow in soil textures ranging from sands to clays and through a wide range of fertility conditions.

Establishment: Seed should always be inoculated. May be seeded alone or mixed with grasses or small grains. Requires a firm seedbed; may be broadcast or drilled. Should be seeded in early spring at 25 to 40 lbs. per acre or one-half to 1 lb. per 1000 square feet, depending on use. (Use lower figure as half the seeding rate of any spring seeding with grass or grain.) Should not be mowed at less than three inches. Lespedeza will not make a large contribution in sod grasses like Bluegrass; they do best in open sod grasses like tall fescue.

Sources: Seed of common variety (Kobe) and Korean varieties (Climax, Harbin and Rowan) are commercially available.

Annual Lespedezas (Lespedeza striata)

PERENNIALS

1. Tall Fescue (Festuca arundinacea)

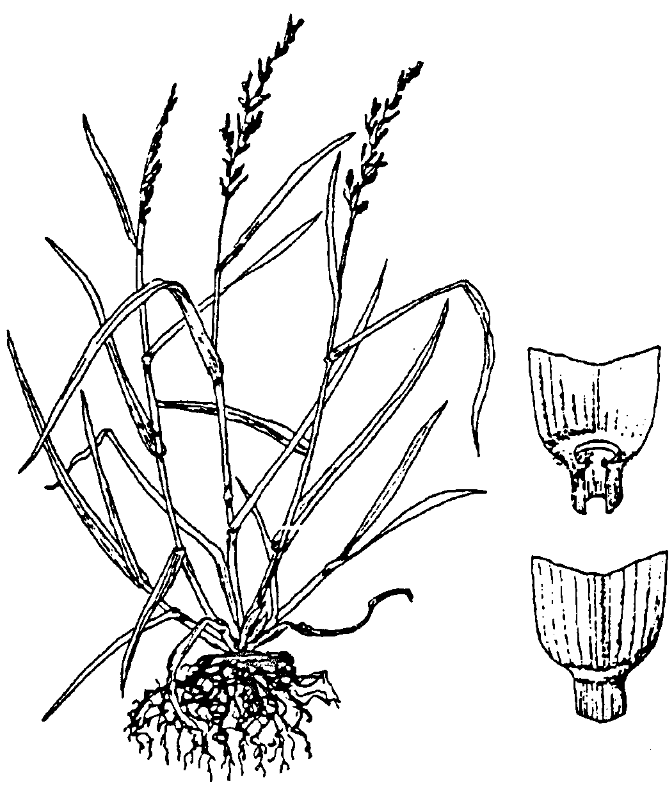
Uses: Pasture, hay, recreation areas, lawns and stabilization of waterways, banks, slopes, cuts, fills, and spoils. It is the most widely used grass at this time for stabilizing large disturbed areas.

Description: A robust, cool season, long-lived, deep-rooted bunchy grass which may have short rhizomes (underground stems). Kentucky 31 is the best-known variety. A number of new varieties of Tall Fescue are becoming available for lawn and other fine-turf uses, and several offer definite improvements. However, their higher cost over the old standby, KY 31, is seldom justified when used for purposes of stabilization and erosion control. Tall Fescue tolerates a wide range of seeding dates; however, with the possible exception of high mountain elevation, it is most dependable when planted in fall.

Adaptation: Adapts well to both high and low maintenance uses throughout Virginia. Adapted to a wide range of climatic conditions. Optimum pH range is 6.0 to 7.0; will tolerate from 3.0 to 8.0. Will grow on shallow and claypan soils if they are moist. Growth is limited more by moisture than by temperature extremes, but it will tolerate drought, infertile soils and moderate shade.

Establishment: Requires a firm seedbed. Hydroseeding is successful. Seeding rates vary from 100 lbs. per acre for erosion control to 250 lbs. per acre for lawns. Plant in early spring or from the middle of August through September. Legumes may not thrive in fescue stands due to the aggressive growth habits of this grass. Mowing is desirable on critical areas at least once every two years; lack of periodic mowing will encourage clumpiness.

Sources: Readily available as seed and sod.



Tall Fescue (Festuca arundinacea)

2. Kentucky Bluegrass (Poa pratense)

Uses: Pasture, turf for lawns, athletic fields, golf courses, and playgrounds. Also used to stabilize waterways, slopes, cuts and fills. Choice food for grouse, turkeys, deer and rabbits.

Description: Long-lived, cool season perennial grass which forms a dense sod. Becomes dormant in the heat of summer since its growing season is spring and fall.

Adaptation: Best adapted to well-drained, fertile soils of limestone origin and the climate of northern and western Virginia. Optimum pH range is 6.0 to 7.0. Bluegrasses are better suited to high maintenance situations in the transition zone. Essentially dormant during dry or hot weather; however, it will normally survive severe drought.

Establishment: Requires a firm, weed-free seedbed and adequate fertilization (liberal phosphorus) and lime are important. Can be used with Tall Fescues at low rates. Minimum mowing height is 1-1/2 inches. Critical erosion areas may be mowed only once per year, if desired. This grass is usually seeded with a mixture of other grasses or legumes; several varieties of Bluegrass should be used together to ensure good stand survival. Bare ground rates are 120 lbs. per acre. Overseed 1 to 1-1/2 per 1000 square feet.

Sources: Readily available as seed and sod.

Kentucky Bluegrass (Poa pratense)

3. Perennial Ryegrass (Lolium perrenne)

Uses: Erosion control, soil improvement, lawns, pasture, and hay; newer varieties are excellent for high-traffic areas.

Description: Perennial Ryegrasses are an excellent selection where rapid establishment is desired. Cool season. Ryegrasses cross-pollinate freely so "Common Ryegrass" may be a mixture of annual and perennial species. Certified seed of Perennial Ryegrass varieties is produced: Blaser, Palmer, Goalie, Fiesta II, Ranger, Regal and Pennfine may be used in Virginia.

Perennial Ryegrass (Lolium perrenne)

Adaptation: Throughout Virginia. Grows best on dark, rich soils in mild climates. Newer varieties have good drought tolerance but may require irrigation if under drought stress or heavy traffic. Will tolerate wet soils with good surface drainage.

Establishment: A firm, mellow surface over compact subsoils gives good results. Seed in fall or spring. Perennial Ryegrass may also be seeded in mid-August to early September. For turf, use a rate of 5 to 8 lbs. per 1000 square feet, if seeded alone; lesser amounts are suitable in mixtures, depending on the characteristics of the companion species. Generally not seeded alone except on athletic fields with intensive use. Perennial Ryegrass does best when used with bluegrass as 20 percent or less of the mixture. Ryegrasses germinate rapidly which makes them particularly suited to disturbed-area stabilization and temporary seeding. They will, however, tend to dominate stands in mixtures if percentage is too high.

Sources: Readily available commercially. Care should be taken to buy seed appropriate to the needs of the project.

4. Fine Fescues

* Red Fescue
* Hard Fescue
* Chewings Fescue

Uses: Excellent for shady, low maintenance areas and north-facing slopes. May be used to stabilize waterways, slopes, banks, cuts, fills, and as a cover crop in orchards.

Description: Red Fescue is a cool season perennial that occurs in two forms: bunch-type and creeping. Creeping Red Fescue forms a tight sod. The leaves of Red Fescue are narrow and wiry. Hard Fescues are slow-growing with excellent shade tolerance.

Adaptation: Shade tolerant and somewhat drought-resistant once established. Grows well in sandy and acidic soils. Optimum pH range is 4.5 to 6.0. Prefers well-drained soils but requires adequate moisture for establishment. In areas of high temperature and humidity (such as southeastern Virginia), some Fine Fescues may turn brown or deteriorate during the summer. Newer varieties of Hard Fescue are more drought tolerant.

Establishment: Rarely seeded in pure stands. Seedbed preparation and fertility adjustments are usually dictated by the other grasses in the mixture. Red Fescues may comprise 25 to 60% by weight of a seeding mixture. In shaded areas red fescue may be the key grass in the mixture. Mowing consistently below 1-1/2 is not recommended.

Sources: Readily available commercially. New Hard Fescues may be in short supply.

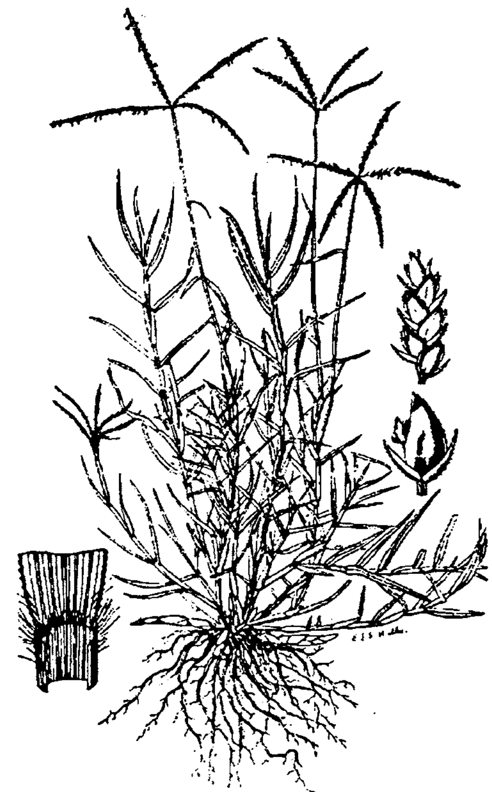
Red Fescue (Festuca rubra)

5. Bermudagrass (Cynodon dactylion)

Uses: Soil and water conservation, pasture, hay, silage, lawns, both high maintenance and general purpose turf, and stabilization of grassed waterways.

Description: A long-lived, warm season perennial that spreads by stolons and rhizomes (runners and underground stems). Height of stems of Common Bermudagrass may be 12 inches. The stems are short-jointed and the leaves flat and spreading. Common Bermudagrass may be established vegetatively with sprigs (sections of stems) or from seeds; however, it has the potential to develop into a weed problem because it spreads vigorously. Cold-tolerant hybrids are usually specified. These are traditionally established from sprigs or sod, but seed is now available.

Adaptation: Southern Piedmont and Coastal Plain in Virginia and some southern appalachian ridges and valleys. Check Std. & Spec. 3.34 for regional adaptations of varieties. Makes its best growth when average daily temperatures are above 75 degrees. Grows on a wide range of soils from heavy clays to deep sands. Optimum pH is 6.0 to 6.5. It is drought-resistant and salt-tolerant. Tolerates floods of short duration but will not thrive on waterlogged soils; does not persist under heavy shade. For rough areas, the varieties Midland (a forage hybrid) and Coastal are recommended. For fine-turf areas, Tufcote (a fine-leaved turf hybrid), Midiron, Tifway, and Vamont are used in Virginia.



Bermudagrass (Cynodon dactylion)

Establishment: By sodding or planting sprigs. Sprigs should be planted (by hand or machine) when soil is warm in a well-prepared, moist seedbed. One end of the sprig should extend above ground, and the other should be covered by firmly packed soil.

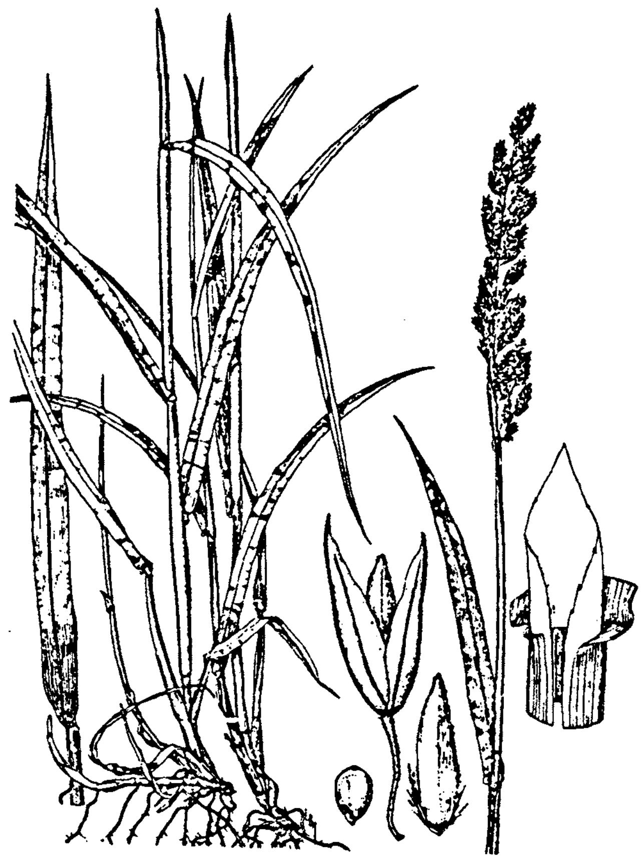
Sources: Readily available as seed, sprigs, and sod.

6. Reed Canarygrass (Phalaris arundinacea)

Uses: Pasture, hay silage, and erosion control. An excellent grass for stabilizing waterways, healing and controlling gullies, and protecting shorelines of ponds and reservoirs from wave action. Also provides good cover for shooting preserves. Can be used in deep gullies and drainage ditches where streamflow is rapid. Vigorous growth may impede flow in small, low velocity channels.

Description: A long-lived, cool season, clumpy perennial with coarse rhizomes (underground stems). Grows 4 to 7 feet tall. Most widely used variety is Ioreed.

Adaptation: Throughout Virginia. Does best in a cool, moist climate. Makes best growth on fertile, moist, medium to fine soils; but will grow in a wide range of soil moisture conditions. Will also grow well on swampy or floodplain soils consisting of peat, muck or sand. Will withstand flooding, yet is quite drought-tolerant when mature. Optimum pH range 5.0 to 7.5.



Reed Canarygrass (Phalaris arundinacea)

Establishment: Requires a well-prepared seedbed that is firm and weed free. Seed in spring or late summer; drill seed alone or with a legume. Seed must be fresh - it should be labeled as having at least 70% germination tested within the last 6 months. Normally, pure stands should be established because this grass is not very compatible with other plants. Mowing should not occur more than twice a year on stabilized critical erosion areas or waterway as this will result in reduced stands.

Sources: Available commercially.

MISCELLANEOUS EROSION CONTROL GRASSES

1. Weeping Lovegrass (Eragrostis curvula)

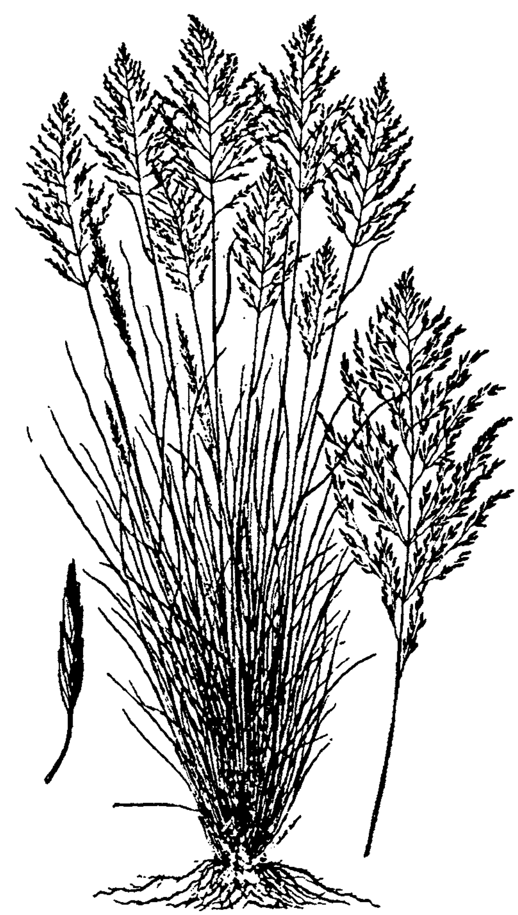
Uses: Fast-growing cover for erosion control. In the northeast, weeping lovegrass acts as a summer annual. The normal life of 3 to 5 years may be foreshortened by low winter temperatures. May provide permanent cover on southern exposure.

Description: A rapid-growing, warm season bunch grass introduced from East Africa. The long, narrow leaves are numerous, very fine, and droop over to the ground, hence the name. Leaf height is rarely above 12 inches.

Adaptation: Prefers light-textured, well-drained soil; will thrive on soil of low fertility. Low winter temperatures may deplete stand.

Establishment: Easy to establish by seed; germinates rapidly and grows quickly. Lime and fertilizer needs are similar to those of Tall Fescue and Ryegrass. Requires pH of 5.5 or higher. May be planted any time after danger of frost and throughout the summer. Very fine seed, commonly added to erosion control seed mixtures. Use of hydroseeders is successful if the seeding rate is increased to compensate for the lack of a firm seedbed. Normal seeding rates are 5 to 20 lbs. per acre in mixes.

Sources: Readily available from large seed companies.



Weeping Lovegrass (Eragrostis curvula)

2. Redtop (Agrostis alba)

Uses: Erosion control, pasture, companion grass in turf seedings and stabilizing ditch and channel banks, grassed waterways, and other disturbed areas.

Description: A coarse, cool season perennial grass with rhizomes (underground stems). Grows to 30 to 40 inches.

Redtop (Agrostis alba)

Adaptation: Throughout Virginia; does better in the cool, humid areas. Will grow under a wide variety of soil and moisture conditions. Grows on very acid soils (pH 4.0 to 7.5) and poor, clay soils of low fertility. While drought-resistant, it is also a useful wetland grass.

Establishment: Has very small seed and requires a compact seedbed. May be sown in early spring or late summer. Seldom seeded alone except as temporary turf. Adequate fertilization is essential on critical areas to obtain good cover rapidly. Most commonly added to mixes, usually 2 to 3 lbs. per acre. Redtop will disappear from a stand under frequent low mowing.

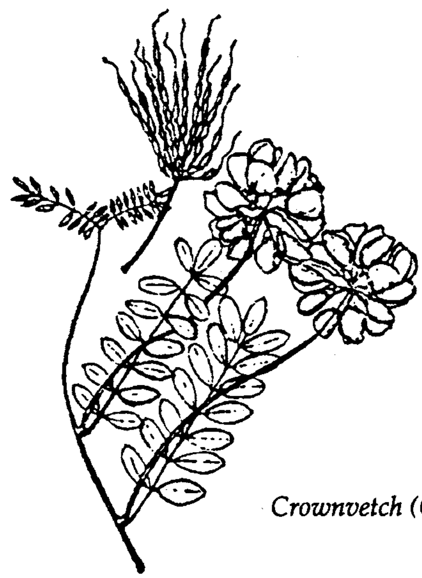
Sources: Available from commercial sources.

LEGUMES

1. Crownvetch (Coronilla varia)

Uses: For erosion control of critical areas such as steep roadbanks, surface mine spoil and industrial waste areas. It is also useful as a residential ground cover. It provides high-quality forage for ruminant animals and serves as a wildlife food and cover plant.

Description: A deep-rooted, cool season, perennial, herbaceous legume with a semi-reclining growth habit. It reaches 2 to 3 feet in height, and does not climb or twine. It fixes nitrogen in the soil and makes a dense mat of vegetative cover.



Crownvetch (Coronilla varia)

Adaptation: Best adapted to the northern Piedmont and Mountain regions of Virginia. It grows best on well-drained soils with a pH range of 5.5 to 8.3. It will persist on more acid soils for a prolonged period once established. It is not adapted to soils with poor drainage. Crownvetch is winter-hardy and drought-tolerant. Varieties commonly used are Chemung, Penngift and Emerald.

Establishment: Only inoculated seed should be used. Requires at least 500 lbs. per acre of 5-10-10 fertilizer (or the area should be fertilized according to soil test results). Soil acidity must be raised above a pH of 5.5. Crownvetch requires mulch and can be hydroseeded successfully. Seeding in the spring is most successful. Frost-seeding may be used on steep or stony sites (seed in late winter, and allow frost action to work the seed into soil). Crownvetch often takes 2 to 3 years to establish a dense stand. A companion grass such as Perennial Ryegrass or Redtop needs to be mixed into the initial planting, but the Crownvetch will eventually crowd out the companion plants. It will not persist under frequent mowing.

Sources: Available commercially.

2. Flatpea (Lathyrus sylvestris)

Uses: Flatpea is an erosion control plant that provides a thick mat of vegetative cover, fixes nitrogen in the soil, and can be maintained with a minimum of management. It is useful on roadbanks, dams, borrow area, gravel pits, surface mine spoil, and industrial waste areas. It is an ideal plant for stabilizing logging roads and utility right-of-ways since it will restrict the invasion of many woody species. It also provides good wildlife cover and food.


Flatpea (Lathyrus sylvestris)

Description: A cool season perennial legume. It will climb to a height of 6 to 7 feet if support is available, but the normal height is 2 to 3 feet.

Adaptation: Flatpea is adaptable to a wide variety of soil conditions. It is drought-tolerant, cold-hardy, and does well on low-fertility sites such as sands, gravels, and soils from acid sandstones. It is not adapted to wet sites, but it will grow on somewhat poorly drained soils. It will tolerate minor shade and a minor degree of flooding. The optimum pH range is from 6.0 to 6.5. The only available variety is Lathco, developed by the USDA-Soil Conservation Service.

Establishment: Use only inoculated seed. The seedbed should be scarified, if possible. The seed is normally drilled or band seeded, but on rough sites or steep slopes, it can be broadcast and then worked into the soil by light dragging. Where possible, a light application of mulch, properly anchored, will assure a good stand. Lime is essential if the soil is below a pH of 5.0. Fertilize according to a soil test or apply 400 lbs. per acre of 10-20-10. Work lime and fertilizer into soil when preparing the seedbed. For a primary stand, use a seeding rate of 30 to 40 lbs. in a mixture with 8 to 10 lbs. of Perennial Ryegrass or 10 to 15 lbs. of Tall Fescue. Flatpea is slow to germinate, so grasses are needed to provide quick cover. Early spring seedings in April or May are best; June seedings are less desirable. Grass seedings may be overseeded with Flatpea from November through March. Flatpea is usually not winter-hardy if seeded in mid or late summer; therefore, dormant seedings are recommended. Mulch with straw at a minimum rate of 1-1/2 tons per acre on all critical sites, and anchor. Little management is required. Remove woody vegetation if the site is invaded. Mowing is acceptable once the stand is established. Mow after full bloom at a 6-inch minimum height.

Sources: Lathco is commercially available.

3. Sericea Lespedeza (Lespedeza cuneata)

Uses: Hay, pasture, erosion control, cover crop, wildlife food.

Description: Warm season perennial legume with upright woody stems 12 to 18 inches tall. Roots widely branched penetrating soil 3 feet or more.

Adaptation: Well adapted to all parts of Virginia. Best on well-drained, deep soils of medium texture. Will also grow on sandy, rather acidic, infertile soils. Most often the legume of choice for eastern Virginia. Optimum pH range is 6.0 to 6.5, but will tolerate a range of 5.0 to 7.0. It is drought-tolerant. Common varieties in Virginia are Serala and Interstate.

Sericea Lespedeza (Lespedeza cuneata)

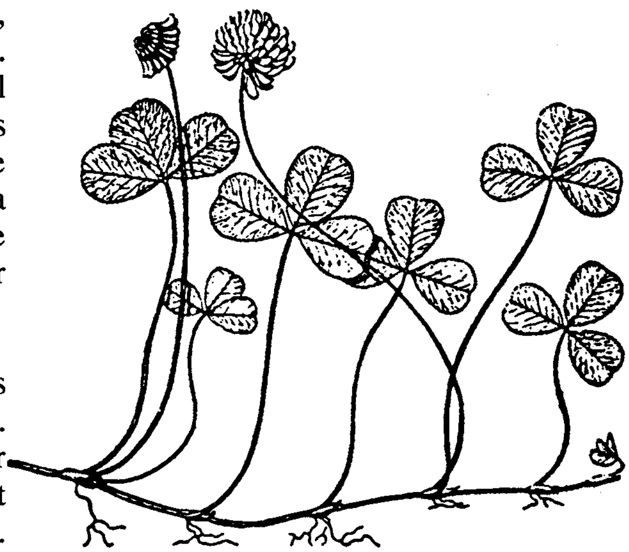
Establishment: Seed from April to June. Requires a firm seedbed. Use only inoculated seed. Rates vary from 20 to 30 lbs. of unhulled seed per acre. Requires phosphate and potash. Will not persist under frequent mowing (once a year recommended).

Sources: Seed of common varieties is commercially available.

4. White Clover (Trifolium repens)

Uses: Common White Clover is used mostly for pastures. Ladino clover, a giant white clover, is also used for hay and silage in mixtures with a grass. The thick-growing, spreading characteristics of the common type make it ideal for erosion control.

Description: A cool season perennial legume. The common type has a prostrate type of growth, while the Ladino is more upright. Both spread by stolons (horizontal branches along ground) and by roots at the nodes. Representative common varieties used in Virginia are Tillman, Common and White Dutch. Ladino is the only cultivar for the large type.



White Clover (Trifolium repens)

Adaptation: Thrives in cool climates and on moist, rich soils with full sun. Will not tolerate extremes of cold or drought. Where soil moisture is not adequate, Ladino is short-lived. Optimum soil pH is 6.5, but it will grow in a range of 5.0 to 7.5. Common White Clover volunteers readily in Bluegrass mixtures where moderate to high fertility is maintained. Stands are persistent.

Establishment: Ladino Clover requires inoculation, fertilizing, and liming for successful growth. Phosphorus and potash are the key fertilizer elements required. Ladino makes a good companion crop with grasses such as Orchardgrass, Bromegrass, Tall Fescue and Timothy. These grasses will normally crowd out the Ladino after 2 to 3 years. Seed should be planted (drilled or broadcast) at shallow depths, and a firm seedbed is desirable.

Sources: Available commercially.

APPENDIX 3.32-d

TABLE 3.32-F

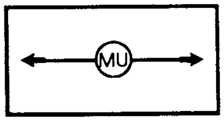
LBS. OF GROUND AGRICULTURAL LIMESTONE* PER THOUSAND SQUARE FEET NEEDED TO CORRECT pH LEVEL OF ACID SOILS TO 6.5

Existing pH	Soil Texture		
	Sandy Loam	Loam	Clay Loam
6.2	20	35	40
6.0	40	55	70
5.8	55	65	85
5.6	70	80	105
5.4	90	100	125
5.2	105	120	140
5.0	120	140	160
4.8	125	180	205
4.6	155	210	230
4.0	200	250	300

* Lime should always be applied in accordance with the results of a soil test, such as may be obtained through the soil testing laboratory at VPI&SU or through a reputable commercial laboratory.

Source: DSWC's Basic Urban E&S in Virginia

STD & SPEC 3.35



MULCHING

Definition

Application of plant residues or other suitable materials to the soil surface.

Purposes

1. To prevent erosion by protecting the soil surface from raindrop impact and reducing the velocity of overland flow.

2. To foster the growth of vegetation by increasing available moisture and providing insulation against extreme heat and cold.

Conditions Where Practice Applies

1. Areas which have been permanently seeded (see Std. & Spec. 3.32, PERMANENT SEEDING) should be mulched immediately following seeding.

2. Areas which cannot be seeded because of the season should be mulched to provide some protection to the soil surface. An organic mulch should be used, and the area then seeded as soon weather or seasonal conditions permit. It is not recommended that fiber mulch be used alone for this practice; at normal application rates it just simply does not provide the protection that is achieved using other types of mulch.

3. Mulch may be used together with plantings of trees, shrubs, or certain ground covers which do not provide adequate soil stabilization by themselves.

4. Mulch shall be used in conjunction with temporary seeding operations as specified in TEMPORARY SEEDING, Std. & Spec. 3.31.

Planning Considerations

Mulches are applied to the soil surface to conserve a desirable soil property or to promote plant growth. A surface mulch is one of the most effective means of controlling runoff and erosion on disturbed land.

Mulches can increase the infiltration rate of the soil, reduce soil moisture loss by evaporation, prevent crusting and sealing of the soil surface, modify soil temperatures, and provide a suitable microclimate for seed germination.

Organic mulch materials, such as straw, wood chips, bark, and fiber mulch have been found to be the most effective.

Chemical soil stabilizers or soil binders should not be used alone for mulch. These materials are useful to bind organic mulches together to prevent displacement.

A variety of manufactured SOIL STABILIZATION BLANKETS AND MATTING (see Std. & Spec. 3.36) have been developed for erosion control in recent years. Some of these products can be used as mulches, particularly in critical areas such as waterways. They also may be used to hold other mulches to the soil surface.

The choice of materials for mulching will be based on the type of soil to be protected, site conditions, season and economics. It is especially important to mulch liberally in mid-summer and prior to winter, and on cut slopes and southern slope exposures.

Organic Mulches

Straw - The mulch most commonly used in conjunction with seeding. The straw should come from wheat or oats (free of troublesome weed seeds) and may be spread by hand or machine. Straw can be windblown and must be anchored down by an acceptable method.

Hay - May be used in lieu of straw where volunteers will not present a problem, and may be spread by hand or machine. Hay can be windblown and must also be anchored or tacked down.

Corn Stalks - These should be shredded into 4- to 6-inch lengths. Stalks decompose slowly and are resistant to displacement.

Wood Chips - Suitable for areas that will not be closely mowed, and around ornamental plantings. Chips decompose slowly and do not require tacking. They must be treated with 12 pounds of nitrogen per ton to prevent nutrient deficiency in plants; however, can be a very inexpensive mulch if chips are obtained from trees cleared on the site.

Bark Chips, Shredded Bark - These are by-products of timber processing which are used in landscaped plantings. Bark is also a suitable mulch for areas planted to grasses and not closely mowed. It may be applied by hand or mechanically and is not usually toxic to grasses or legumes; additional nitrogen fertilizer is not required.

Fiber Mulch - Used in hydroseeding operations and applied as part of the slurry. It creates the best seed-soil contact when applied over top of (as a separate operation) newly seeded areas. These fibers do not require tacking, although tacking agents or binders are sometimes used in conjunction with the application of fiber mulch. This form of mulch does not provide sufficient protection to highly erodible soils. Additionally, fiber mulch will not be considered adequate mulch when used during the dry summer months or when used for late fall mulch cover. Use straw mulch during these periods. Fiber mulch may be used to tack (anchor) straw mulch. This treatment is well suited for steep slopes, critical areas, and areas susceptible to displacement.

There are other organic materials which make excellent mulches but are only available locally or seasonally. Creative use of these materials can reduce costs.

Chemical Mulches and Soil Binders

A wide range of synthetic, spray-on materials are marketed to stabilize and protect the soil surface. These are emulsions or dispersions of vinyl compounds, rubber or other substances which are mixed with water and applied to the soil. They may be used alone in some cases as temporary stabilizers, or in conjunction with fiber mulches or straw.

When used alone, chemical mulches do not have the capability to insulate the soil or retain soil moisture that organic mulches have. This soil protection is also easily damaged by traffic. Application of these mulches is usually more expensive than organic mulching, and the mulches decompose in 60-90 days.

Blankets and Matting

Field experience has shown that plastic netting, when used alone, does not retain soil moisture or modify soil temperature. In some cases it may stabilize the soil surface while grasses are being established, but is primarily used in grassed waterways and on slopes to hold straw or similar mulch in place.

Jute mesh and other soil stabilization blankets are good choices for mulching on difficult slopes and in minor drainage swales. Most of the soil stabilization mattings (used to create a permanent matrix for root growth within the soil) must receive mulching in order to properly stabilize an area. Notably, some manufacturers have recently developed permanent mattings which include self-contained, temporary mulching materials; however, these measures will have to meet the requirements noted in Std. & Spec. 3.36, SOIL STABILIZATION BLANKETS AND MATTING, before they can be recommended for use on steep slopes and in channel flow situations.

The most critical aspect of installing blankets and mats is obtaining firm, continuous contact between the material and the soil. Without such contact, the material may fail and thereby allow erosion to occur. It is important to use an adequate number of staples and make sure the material is installed properly in order to maximize soil protection. These products are discussed in more detail in Std. & Spec. 3.36, SOIL STABILIZATION BLANKETS & MATTING.

Specifications

Organic Mulches

Organic mulches may be used in any area where mulch is required, subject to the restrictions noted in Table 3.35-A.

Materials: Select mulch material based on site requirements, availability of materials, and availability of labor and equipment. Table 3.35-A lists the most commonly used organic mulches. Other materials, such as peanut hulls and cotton burs, may be used with the permission of the local Plan-Approving Authority.

Prior to mulching: Complete the required grading and install needed sediment control practices.

Lime and fertilizer should be incorporated and surface roughening accomplished as needed. Seed should be applied prior to mulching except in the following cases:

a. Where seed is to be applied as part of a hydroseeder slurry containing fiber mulch.

b. Where seed is to be applied following a straw mulch spread during winter months.

TABLE 3.35-A

ORGANIC MULCH MATERIALS AND APPLICATION RATES

MULCHES:	RATES: Per Acre	RATES: Per 1000 sq. ft.	NOTES:
Straw or Hay	1½ - 2 tons (Minimum 2 tons for winter cover)	70 - 90 lbs.	Free from weeds and coarse matter. Must be anchored. Spread with mulch blower or by hand.
Fiber Mulch	Minimum 1500 lbs.	35 lbs.	Do not use as mulch for winter cover or during hot, dry periods.* Apply as slurry.
Corn Stalks	4 - 6 tons	185 - 275 lbs.	Cut or shredded in 4-6" lengths. Air-dried. Do not use in fine turf areas. Apply with mulch blower or by hand.
Wood Chips	4 - 6 tons	185 - 275 lbs.	Free of coarse matter. Air-dried. Treat with 12 lbs nitrogen per ton. Do not use in fine turf areas. Apply with mulch blower, chip handler, or by hand.
Bark Chips or Shredded Bark	50 - 70 cu. yds.	1-2 cu. yds.	Free of coarse matter. Air-dried. Do not use in fine turf areas. Apply with mulch blower, chip handler, or by hand.

* When fiber mulch is the only available mulch during periods when straw should be used, apply at a minimum rate of 2000 lbs./ac. or 45 lbs./1000 sq. ft.

Source: Va. DSWC

Application: Mulch materials shall be spread uniformly, by hand or machine.

When spreading straw mulch by hand, divide the area to be mulched into approximately 1,000 sq. ft. sections and place 70-90 lbs. (1½ to 2 bales) of straw in each section to facilitate uniform distribution.

Mulch Anchoring: Straw mulch must be anchored immediately after spreading to prevent displacement. Other organic mulches listed in Table 3.35-A do not require anchoring. The following methods of anchoring straw may be used:

1. Mulch anchoring tool (often referred to as a Krimper or Krimper Tool): This is a tractor-drawn implement designed to punch mulch into the soil surface. This method provides good erosion control with straw. It is limited to use on slopes no steeper than 3:1, where equipment can operate safely. Machinery shall be operated on the contour.

2. Fiber Mulch: A very common practice with widespread use today. Apply fiber mulch by means of a hydroseeder at a rate of 500-750 lbs./acre over top of straw mulch or hay. It has an added benefit of providing additional mulch to the newly seeded area.

3. Liquid mulch binders: Application of liquid mulch binders and tackifiers should be heaviest at edges of areas and at crests of ridges and banks, to prevent displacement. The remainder of the area should have binder applied uniformly. Binders may be applied after mulch is spread or may be sprayed into the mulch as it is being blown onto the soil.

   The following types of binders may be used:

   a. Synthetic binders - Formulated binders or organically formulated products may be used as recommended by the manufacturer to anchor mulch.

   * b. Asphalt - Any type of asphalt thin enough to be blown from spray equipment is satisfactory. Recommended for use are rapid curing (RC-70, RC-250, RC-800), medium curing (MC-250, MC-800) and emulsified asphalt (SS-1, CSS-1, CMS-2, MS-2, RS-1, RS-2, CRS-1, and CRS-2).

      Apply asphalt at 0.10 gallon per square yard (10 gal./1000 sq. ft. or 430 gal./acre). Do not use heavier applications as it may cause the straw to "perch" over rills. All asphalt designations are from the Asphalt Institute Specifications.

* Note: This particular method is not used as commonly today as it once was in the past. The development of hydraulic seeding equipment promoted the industry

to turn to synthetic or organically based binders and tackifiers. When this method is used, environmental concerns should be addressed to ensure that petroleum-based products do not enter valuable water supplies. Avoid applications into waterways or channels.

4. Mulch nettings: Lightweight plastic, cotton, or paper nets may be stapled over the mulch according to manufacturer's recommendations.

5. Peg and twine: Because it is labor-intensive, this method is feasible only in small areas where other methods cannot be used. Drive 8- to 10-inch wooden pegs to within 3 inches of the soil surface, every 4 feet in all directions. Stakes may be driven before or after straw is spread. Secure mulch by stretching twine between pegs in a criss-cross-within-a square pattern. Turn twine 2 or more times around each peg.

Chemical Mulches

Chemical mulches* may be used alone only in the following situations:

a. Where no other mulching material is available.

b. In conjunction with temporary seeding during the times when mulch is not required for that practice.

c. From March 15 to May 1 and August 15 to September 30, provided that they are used on areas with slopes no steeper than 4:1, which have been roughened in accordance with SURFACE ROUGHENING, Std. & Spec. 3.29. If rill erosion occurs, another mulch material shall be applied immediately.

* Note: Chemical mulches may be used to bind other mulches or with fiber mulch in a hydroseeded slurry at any time. Manufacturer's recommendations for application of chemical mulches shall be followed.

Maintenance

All mulches and soil coverings should be inspected periodically (particularly after rainstorms) to check for erosion. Where erosion is observed in mulched areas, additional mulch should be applied. Nets and mats should be inspected after rainstorms for dislocation or failure. If washouts or breakage occur, re-install netting or matting as necessary after repairing damage to the slope or ditch. Inspections should take place up until grasses are firmly established. Where mulch is used in conjunction with ornamental plantings, inspect periodically throughout the year to determine if mulch is maintaining coverage of the soil surface; repair as needed.

STD & SPEC 3.36

Treat. - 1

or

Treat. - 2

SOIL STABILIZATION BLANKETS & MATTING

B/M

Definition

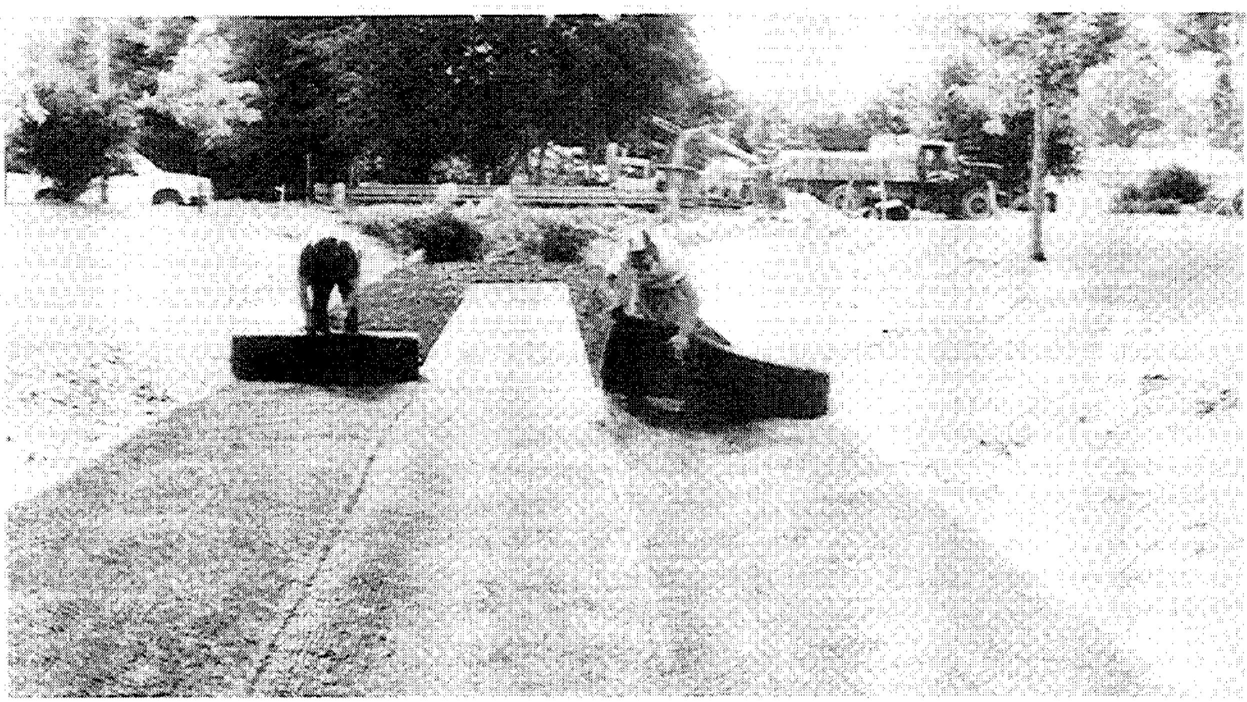
The installation of a protective covering (blanket) or a soil stabilization mat on a prepared planting area of a steep slope, channel or shoreline.

Purpose

To aid in controlling erosion on critical areas by providing a microclimate which protects young vegetation and promotes its establishment. In addition, some types of soil stabilization mats are also used to raise the maximum permissible velocity of turf grass stands in channelized areas by "reinforcing the turf" to resist the forces of erosion during storm events.

Conditions Where Practice Applies

On short, steep slopes where erosion hazard is high and planting is likely to be too slow in providing adequate protective cover; in vegetated channels where the velocity of design flow exceeds "allowable" velocity; on streambanks or tidal shorelines where moving water is likely to wash out new plantings; or in areas where the forces of wind prevent standard mulching practices from remaining in place until vegetation becomes established.



Planning Considerations

Soil stabilization blankets and mats can be applied to problem areas to supplement nature's erosion control system (vegetation) in its initial establishment and in providing a safe and "natural" conveyance for high velocity stormwater runoff. They are being used today in many applications were previously a structural lining would have been required. Care must be taken to choose the type of blanket or matting which is most appropriate for the specific needs of a project. Two general types of blankets and mats are discussed within this specification. However, with the abundance of soil stabilization products available today, it is impossible to cover all the advantages, disadvantages and specifications of all manufactured blankets and mats. Therefore, as with many erosion control-type products, there is no substitute for a thorough understanding of the manufacturer's instructions and recommendations and a site visit by a designer or plan reviewer to verify a product's appropriateness.

Treatment-1 is a degradable soil stabilization blanket which includes "combination" blankets consisting of a plastic netting which covers and is intertwined with a natural organic or man-made mulch; or, a jute mesh which is typically homogeneous in design and can act alone as a soil stabilization blanket.

It should be used to help establish vegetation on previously disturbed slopes - normally problem slopes of 3:1 or greater. Since the materials which compose the soil stabilization blankets will deteriorate over time, they should be used in permanent conveyance channels with the realization that the system's resistance to erosion is based on the type of vegetation planted and the existing soil characteristics. During the establishment of vegetation, **Treatment-1** should not be subjected to shallow or deep concentrated flows moving at greater than 4 feet/second.

Treatment-1 provides the following benefits in the achievement of vegetative stabilization when properly applied over seed and required amendments:

1. Protection of the seed and soil from raindrop impact and subsequent displacement.
2. Thermal consistency and moisture retention for seedbed area.
3. Stronger and faster germination of grasses and legumes.
4. Planing off excess stormwater runoff.
5. Prevention of sloughing of topsoil added to steeper slopes.

Treatment-2 is a soil stabilization matting which consists of a non-degradable, 3-dimensional plastic structure which can be filled with soil prior to planting. This configuration provides a matrix for root growth where the matting becomes entangled and penetrated by roots, forming continuous anchorage for surface growth and promoting enhanced energy dissipation. **Treatment-2** can be used on problem slopes (normally 3:1 or greater), and in stormwater conveyance channels.

In addition to those benefits noted for **Treatment-1**, **Treatment-2** provides the following benefits in the achievement of vegetative stabilization and in the replacement of more traditional channel linings such as concrete and riprap:

1. Causes soil to drop out of stormwater and fill matrix with fine soils which become the growth medium for the development of roots.

2. When embedded in the soil within stormwater channels, it acts with the vegetative root system to form an erosion resistant cover which resists hydraulic lift and shear forces.

Since **Treatment-2** is non-degradable, it can be used in permanent conveyance channels and can withstand higher velocities of flow than the vegetation and soil would normally allow. However, a 10 feet/second velocity of flow should be the maximum allowed in a conveyance system which utilizes **Treatment-2**.

VDOT Nomenclature and Product Information

The Virginia Department of Transportation has its own nomenclature for many of the standards and specifications found in this handbook; this is true in the case of soil stabilization blankets and matting. The following relationship exists between the two methods of naming the practice:

Va. E&S-C Handbook		VDOT Specifications
Treatment-1	(is equivalent to)	EC-2
Treatment-2	(is equivalent to)	EC-3

It is recommended that most current VDOT "Approved Products List" for these products be consulted prior to installation of a particular blanket or mat. Importantly, the list names those products approved for a certain range of flow velocities when **Treatment-2** (VDOT's EC-3) installation is contemplated.

TREATMENT-1: SOIL STABILIZATION BLANKET

(Allowable Velocity Range During Vegetation Establishment: 0 - 4 f.p.s.)

Materials

1. Combination Blankets - They shall consist of a photo-degradable plastic netting which covers and is entwined in a natural organic or man-made mulching material.

The mulching material shall consist of wood fibers, wood excelsior, straw, coconut fiber, or man-made fibers, or a combination of the same. The blanket shall be of consistent thickness with the mulching material/fibers evenly distributed over its entire length. The mulching material/fibers must interlock or entwine to form a dense layer which not only resists raindrop impact, but will allow vegetation to penetrate the blanket.

The blanket shall be nontoxic to vegetation and to the germination of seed and shall not be injurious to the unprotected skin of humans. At a minimum, the plastic netting must cover the top side of the blanket and possess a high web strength. The netting shall be entwined with the mulching material/fiber to maximize strength and provide for ease of handling.

2. Jute Mesh - It shall be of a uniform, open, plain weave, of undyed and unbleached single jute yarn. The yarn shall be of loosely twisted construction and shall not vary in thickness by more than one half of its normal diameter. Jute mesh shall be new and shall conform to the following:

   a. Length of jute mesh shall be marked on each roll.

   b. There shall be 0.60-inch openings (± 25%) between strands, lengthwise.

   c. There shall be 0.90-inch openings (± 25%) between strands, lengthwise.

   d. Weight shall average 0.90 lbs./square yard with a tolerance of 5%.

   As previously noted, jute mesh provides such good coverage (large surface area of strands) and contains such small openings that it can be used alone as a blanket.

3. Other Treatment-1 Products - These shall conform to manufacturer's specifications and be approved by the Plan-Approving Authority prior to being specified for a particular application. These products should be installed in accordance with manufacturer's recommendations, provided those recommendations are at least as stringent as this specification. Again, it is recommended that VDOT's "Approved Products List" be consulted. In no case shall these products cover less than 30% of the soil surface.

4. Staples - Staples for anchoring Treatment-1 shall be No. 11-gauge wire or heavier. Their length shall be a minimum of 6 inches. A larger staple with a length of up to 12 inches should be used on loose, sandy, or unstable soils.

Installation Requirements

Site Preparation - After site has been shaped and graded to approved design, prepare a friable seedbed relatively free from clods and rocks more than 1½ inches in diameter and any foreign material that will prevent uniform contact of the protective covering with the soil surface.

Planting - Lime, fertilize, and seed in accordance with seeding or other type of planting plan. When using jute mesh on a seeded area, apply approximately one-half the seed after laying the mat. The protective covering can be laid over sprigged areas where small grass plants have been inserted into the soil. Where ground covers are to be planted, lay the protective covering first and then plant through the material as per planting design.

When open-weave nets are used, lime, fertilizer, seed and mulch should be applied before laying the net. When a combination blanket (such as an "excelsior" blanket) is used, seed and soil amendments must also be applied before the blanket is laid.

Orientation - See Plate 3.36-1 for orientation of **Treatment-1** for different topographic conditions.

Laying and Stapling (see Plate 3.36-2) - If instructions have been followed, all needed check slots will have been installed, and the protective covering will be laid on a friable seedbed free from clods, rocks, roots, etc. that might impede good contact.

1. Start laying the protective covering from the top of the channel or top of slope and unroll down-grade.

2. Allow to lay loosely on soil - do not stretch.

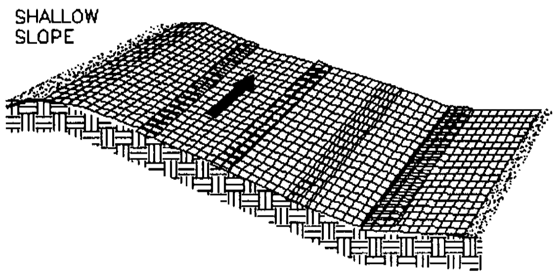
3. Upslope ends of the protective covering should be buried in a anchor slot no less than 6-inches deep. Tamp earth firmly over the material. Staple the material at a minimum of every 12 inches across the top end.

4. Edges of the material shall be stapled every 3 feet. Where multiple widths are laid side by side, the adjacent edges shall be overlapped a minimum of 2 inches and stapled together.

5. Staples shall be placed down the center, staggered with the edges at 3 foot intervals.

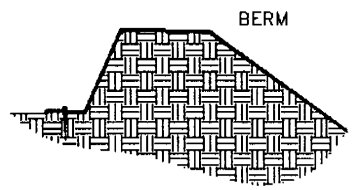
Check slots - On highly erodible soils and on slopes steeper than 4:1, erosion check slots should be made every 50 feet (see Plate 3.36-2). Insert a fold of the material (separate piece) into a 6-inch trench and tamp firmly. Staple fold to "main" blanket at minimum 12-inch intervals across the upstream and downstream portion of the blanket.

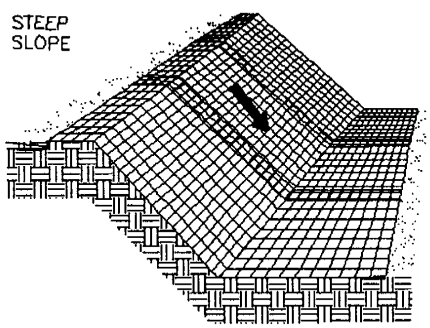
TYPICAL ORIENTATION OF TREATMENT – 1 (SOIL STABILIZATION BLANKET)



ON SHALLOW SLOPES, STRIPS OF NETTING PROTECTIVE COVERINGS MAY BE APPLIED ACROSS THE SLOPE.

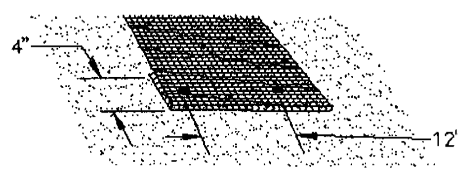
WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE MATERIAL OVER THE BERM AND ANCHOR IT BEHIND THE BERM.

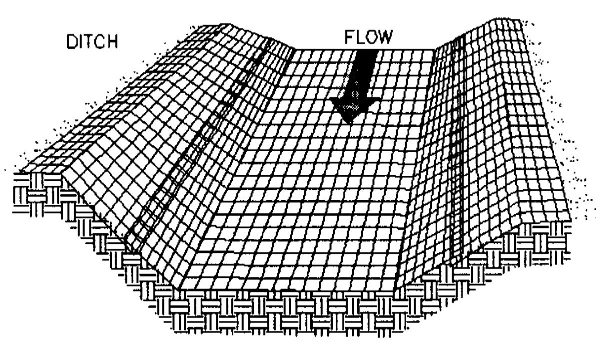




ON STEEP SLOPES, APPLY PROTECTIVE COVERING PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURELY.

BRING MATERIAL DOWN TO A LEVEL AREA BEFORE TERMINATING THE INSTALLATION. TURN THE END UNDER 4" AND STAPLE AT 12" INTERVALS.



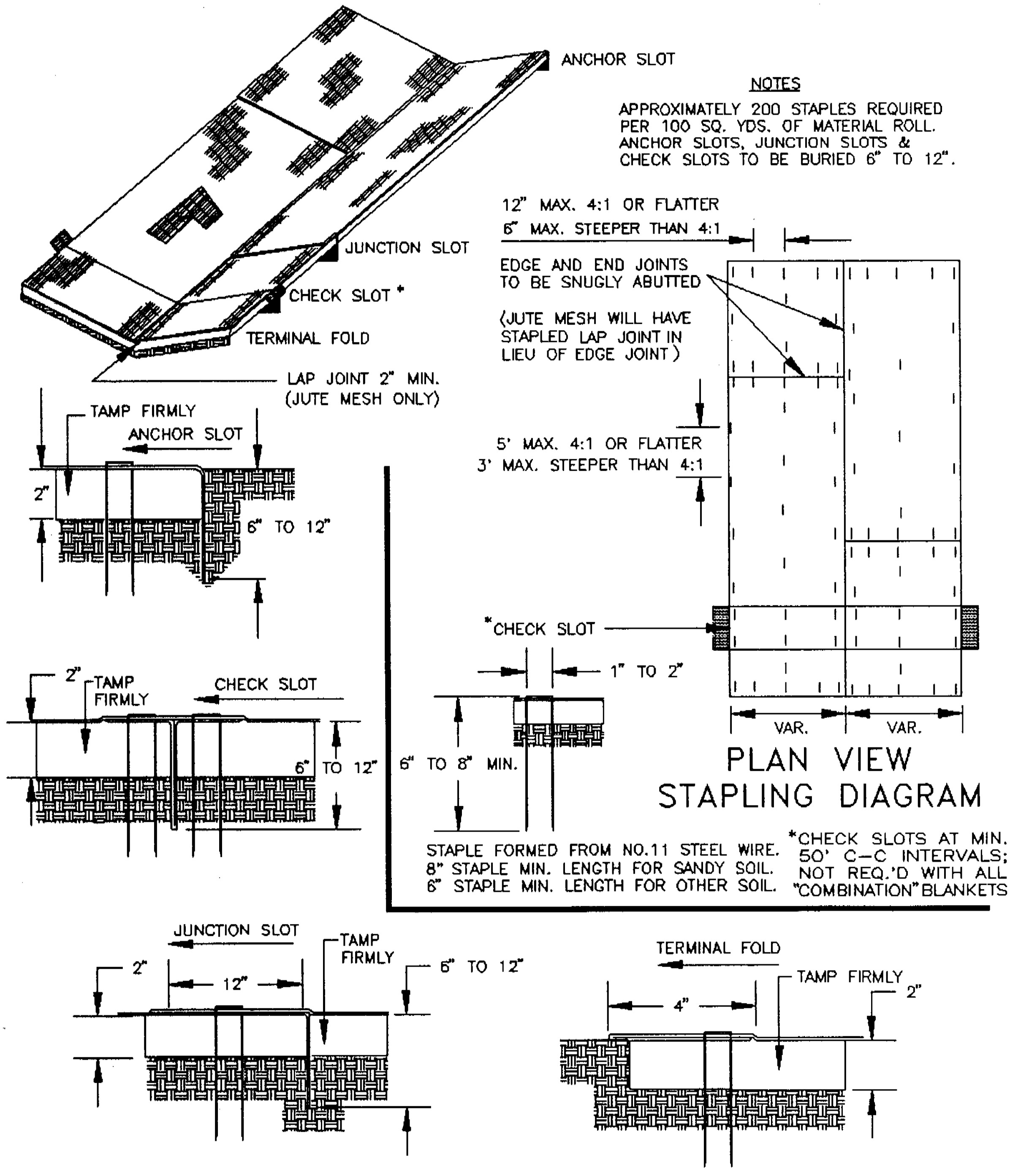


IN DITCHES, APPLY PROTECTIVE COVERING PARALLEL TO THE DIRECTION OF FLOW. USE CHECK SLOTS AS REQUIRED. AVOID JOINING MATERIAL IN THE CENTER OF THE DITCH IF AT ALL POSSIBLE.

Source: Adapted from Ludlow Products Brochure

Plate 3.36-1

TYPICAL TREATMENT – 1 (SOIL STABILIZATION BLANKET) INSTALLATION CRITERIA



Source: VDOT Road and Bridge Standards Plate 3.36-2

Note: Many combination blankets are designed and manufactured to resist movement and uplift to a point which check slots may not be required. Plan designers and review authorities are urged to study manufacturers' recommendations and site conditions.

Joining Protective Coverings - Insert a new roll of material into an anchor slot, as with upslope ends. Overlap the end of the previous roll a minimum of 12 inches, and staple across the end of the roll just below the anchor slot and across the material every 12 inches.

Terminal End - At the point at which the material is discontinued, or at which time the protective covering meets a structure of some type, fold 4 inches of the material underneath and staple every 12 inches (minimum).

At bottom of slopes - Lead net out onto a level area before anchoring. Turn ends under 4 inches, and staple across end every 12 inches.

Final Check - These installation techniques must be adhered to:

1. Protective blanket is in uniform contact with the soil.
2. All lap joints are secure.
3. All staples are driven flush with the ground.
4. All disturbed areas have been seeded.

TREATMENT-2: SOIL STABILIZATION MATTING

(Allowable velocity range after vegetative establishment: 0 - 10 f.p.s.)

Materials

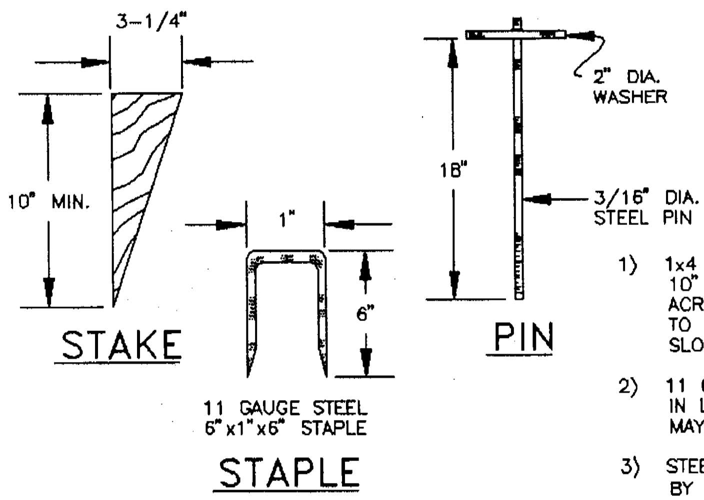
Matting - The majority of these products provide a three dimensional geomatrix of nylon, polyethylene, or randomly oriented monofilaments, forming a mat. These products contain ultra violet (UV) inhibiting stabilizers, added to the compounds to ensure endurance and provide "permanent root reinforcement."

The three dimensional feature creates an open space which is allowed to fill with soil. The roots of the grass plant become established within the mat itself, forming a synergistic root and mat system. As the grass becomes established, the two actually "reinforce" each other, preventing movement or damage to the soil. Allowable velocities are increased considerably over natural turf stands.

Selection of the appropriate matting materials along with proper installation become critical factors in the success of this practice. VDOT's "Approved Products List" can be a real asset in the selection process. Consultation with the supplier or the manufacturer and thorough evaluation of performance data to ensure proper selection of a soil stabilization matting are also essential. Although many manufacturers claim their products may inhibit erosion associated with channel velocities of up to 20 ft./sec., it is recommended that any velocities that exceed 10 ft./sec. be properly protected with some form of structural lining (see Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNEL).

Staples - Staples or anchoring methods and recommendations vary by manufacturers. The expectation of high velocities should dictate the use of more substantial anchoring. Some of the typically recommended stakes, staples and pins are depicted in Plate 3.36-3

STAKES, STAPLES, & PINS FOR INSTALLATION OF TREATMENT - 2 SOIL STABILIZATION MATTING



1) 1x4 TRIANGULAR SURVEY STAKE - MINIMUM 10" IN LENGTH. PLACEMENT OF THE STAKE ACROSS THE FLOW OF THE WATER IS THOUGHT TO PROVIDE A "PINBALL EFFECT" TO HELP SLOW THE VELOCITY.

2) 11 GAUGE STEEL - MINIMUM 1" WIDE BY 6" IN LENGTH STEEL STAPLE - 2"x8" STAPLE MAY BE REQUIRED IN CERTAIN SOIL CONDITIONS.

3) STEEL PINS - 3/16 DIAMETER STEEL PIN BY 18" IN LENGTH WITH A 2" DIAMETER WASHER ON TOP. (SEE ILLUSTRATION)

Source: Product literature from Greenstreak, Inc. Plate 3.36-3

Installation Requirements

Site Preparation - After site has been shaped and graded to approved design, prepare a friable seedbed relatively free from clods and rocks more than 1 inch in diameter, and any foreign material that will prevent contact of the soil stabilization mat with the soil surface. If necessary, redirect any runoff away from the ditch or slope during installation.

Planting - Lime, fertilize and seed in accordance with MS #1 and the approved plan, paying special attention to the plant selection that may have been chosen for the matted area. If the area has been seeded prior to installing the mat, make sure and reseed all areas disturbed during installation.

Mulching - Mulch (normally straw) should be applied following installation of **Treatment-2** at rates noted in Std. & Spec. 3.35, MULCHING.

Laying and Securing - See Plates 3.36-4, 3.36-5 and 3.36-6. Similar to installing **Treatment-1,** but Plan Approving Authority's requirements or manufacturer's recommendations must be followed as detailed. The key to achieving desired performance is dependent upon proper installation.

Check Slots - See Plate 3.36-4. Matting manufacturers vary significantly in their check slot requirements. Similar to the installation of **Treatment-1,** a check slot may be required when laying **Treatment-2** to "correct" the flow of water if it has the potential to undermine the matting. Most authorities (including VDOT) require that the sides of the matting also be entrenched, creating a slope shelf for the material to rest on, preventing water from entering under the mat on the sides.

Securing the Material and Joining Mats - Again, product specifications vary - upstream and downstream terminal slots, new roll overlaps and multiple width installations differ by various products and manufacturers.

Final Check - These installation techniques must be adhered to:

1. Soil stabilization mat is in uniform contact with the soil.

2. All required slots and lapped joints are in place.

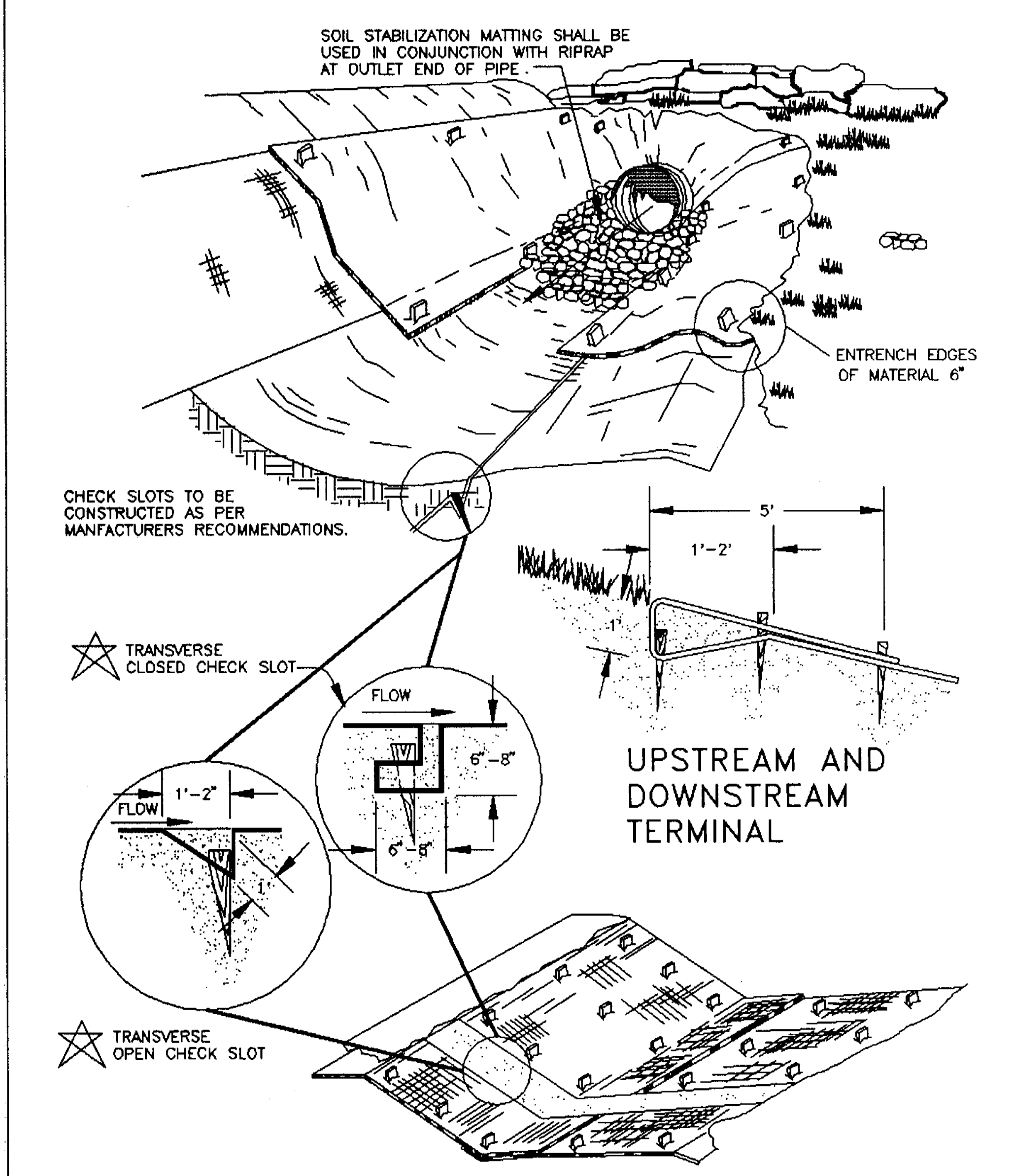
3. The material is properly anchored.

4. All disturbed areas are seeded.

Maintenance

All soil stabilization blankets and matting should be inspected periodically following installation, particularly after rainstorms to check for erosion and undermining. Any dislocation or failure should be repaired immediately. If washouts or breakage occurs, re-install the material after repairing damage to the slope or ditch. Continue to monitor these areas until which time they become permanently stabilized; at that time an annual inspection should be adequate.

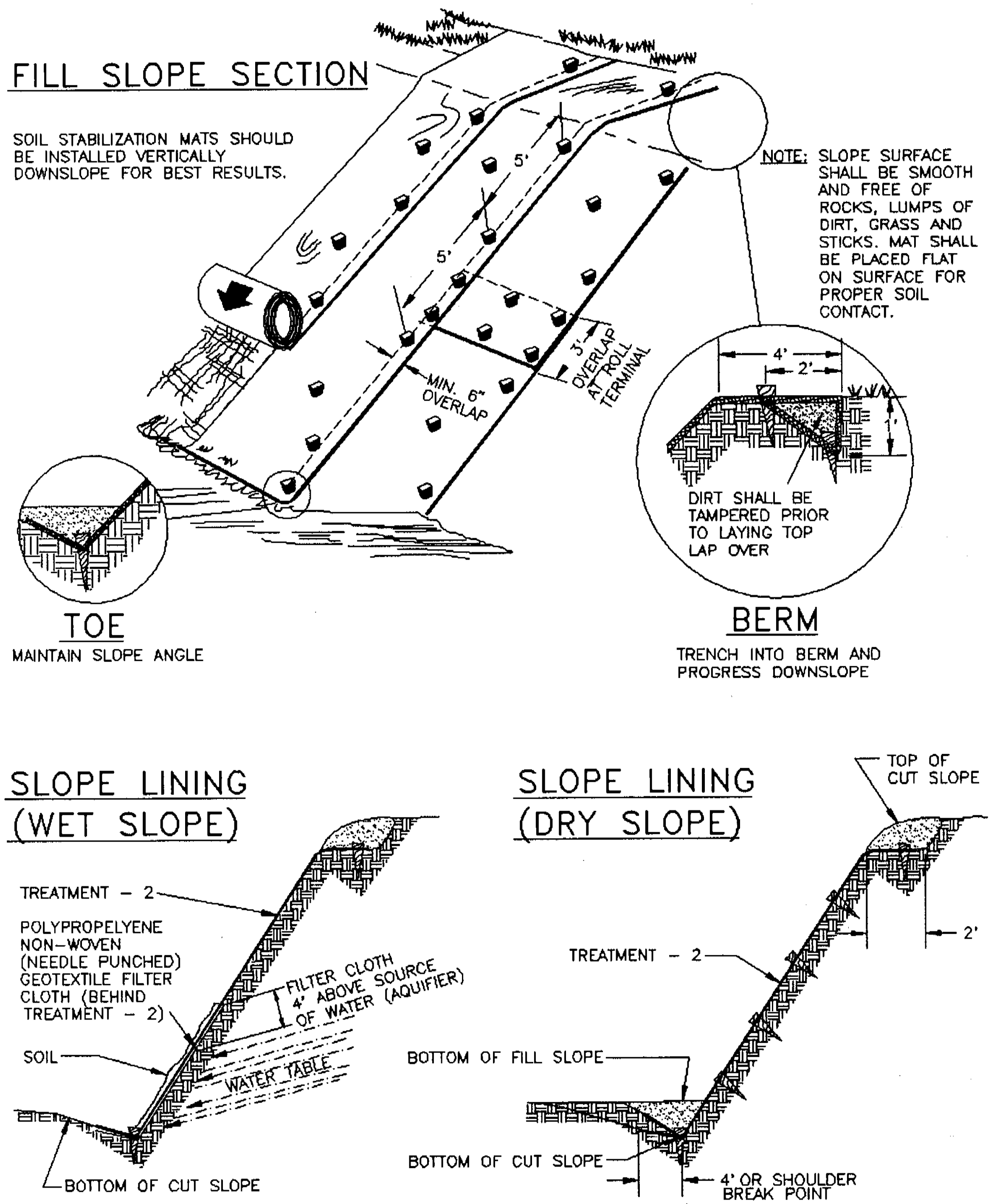
TYPICAL TREATMENT-2 SOIL STABILIZATION MATTING INSTALLATION



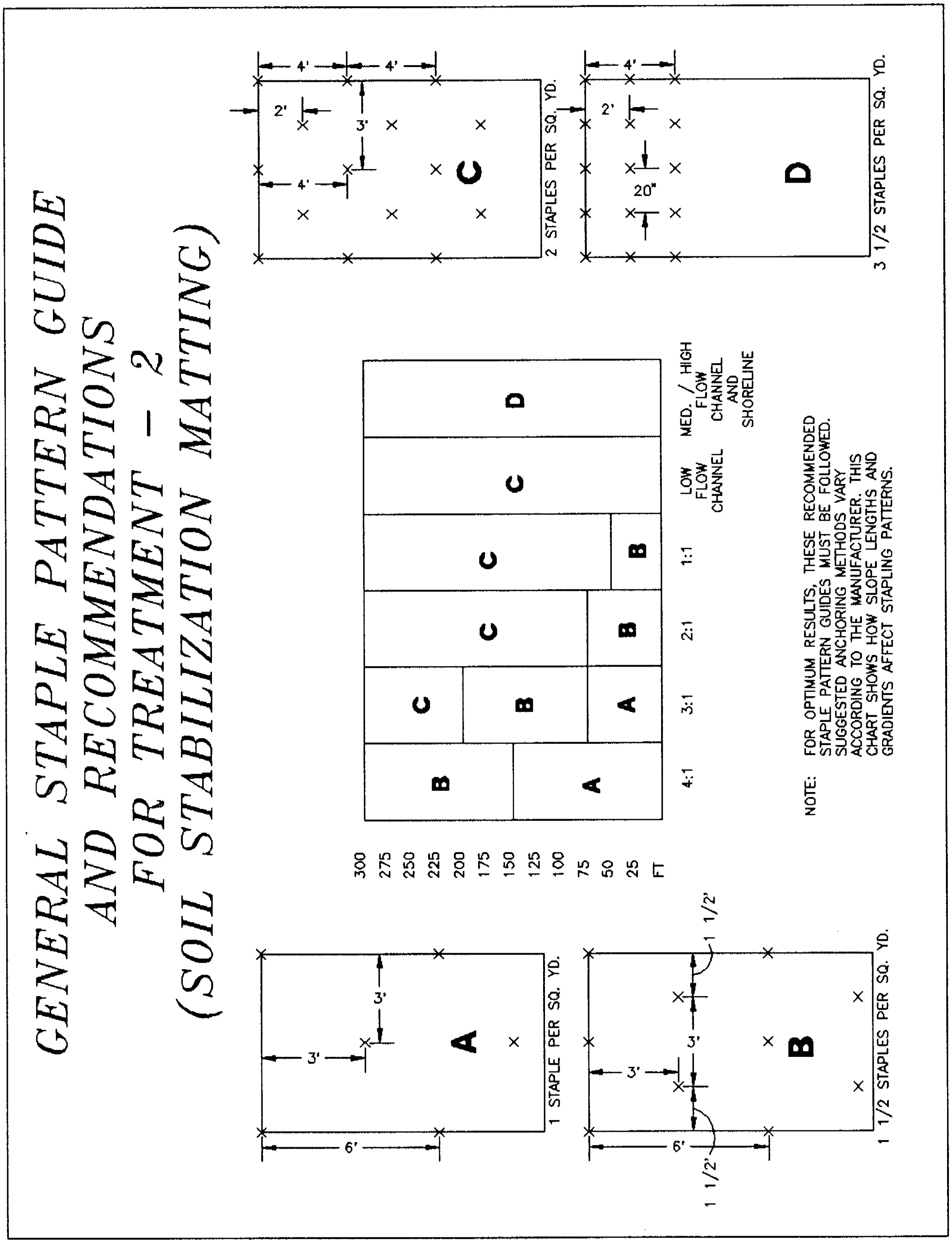
Source: VDOT Road and Bridge Standards

Plate 3.36-4

TYPICAL TREATMENT – 2
SOIL STABILIZATION MATTING
SLOPE INSTALLATION



Source: VDOT Road and Bridge Standards Plate 3.36-5



Source: Product literature from North American Green

Plate 3.36-6

STD & SPEC 3.39

DUST CONTROL

DC

Definition

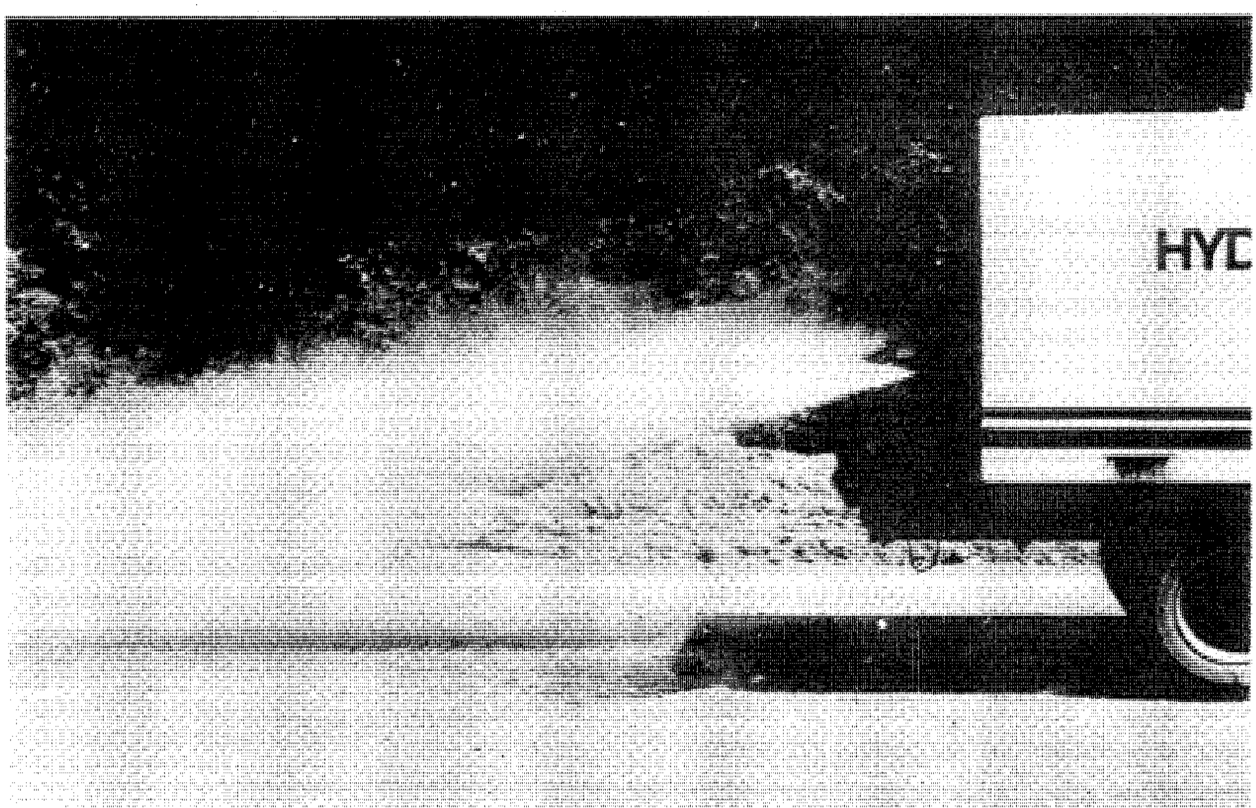
Reducing surface and air movement of dust during land disturbing, demolition and construction activities.

Purpose

To prevent surface and air movement of dust from exposed soil surfaces and reduce the presence of airborne substances which may present health hazards, traffic safety problems or harm animal or plant life.

Conditions Where Practice Applies

In areas subject to surface and air movement of dust where on-site and off-site damage is likely to occur if preventive measures are not taken.



Planning Considerations

Construction activities inevitably result in the exposure and disturbance of soil. Fugitive dust is emitted both during the activities (i.e., excavation, demolition, vehicle traffic, human activity) and as a result of wind erosion over the exposed earth surfaces. Large quantities of dust are typically generated in "heavy" construction activities, such as road and street construction and subdivision, commercial or industrial development, which involve disturbance of significant areas of the soil surface. Research of construction sites has established an average dust emission rate of 1.2 tons/acre/month for active construction. Earth-moving activities comprise the major source of construction dust emissions, but traffic and general disturbance of the soil also generate significant dust emissions.

In planning for dust control, limiting the amount of soil disturbance at any one time should be a key objective. Therefore, phased clearing and grading operations and the utilization of temporary stabilization in accordance with MS #1 can significantly reduce dust emissions. Undisturbed vegetative buffers (minimum 50-foot widths) left between graded areas and protected areas can also be very helpful in dust control.

Temporary Measures Used During Construction

1. Vegetative Cover - In areas subject to little or no construction traffic, a vegetatively stabilized surface will reduce dust emissions (see TEMPORARY SEEDING, Std. & Spec. 3.31).

2. Mulch - When properly applied, mulch offers a fast, effective means of controlling dust. Not recommended for areas within heavy traffic pathways. Binders or tackifiers should be used to tack organic mulches (see MULCHING, Std. & Spec. 3.35).

3. Tillage - This practice is designed to roughen and bring clods to the surface. It is an emergency measure which should be used before wind erosion starts. Begin plowing on windward side of site. Chisel-type plows spaced about 12 inches apart, spring-toothed harrows, and similar plows are examples of equipment which may produce the desired effect.

4. Irrigation - This is the most commonly used dust control practice. Site is sprinkled with water until the surface is wet. Repeat as needed. It offers fast protection for haul roads and other heavy traffic routes.

5. Spray-On Adhesives - Tremendous progress has been made in recent years in the development of products of this type. Most are effective on "mineral" soils and are ineffective on "muck" soils. These coherics are derived from a variety of compounds, both organic and synthetic based. Many of the adhesives will withstand heavy traffic loads. The organics include derivatives from pine tar and vegetable gum; synthetics may be acrylic or petroleum based.

The following table list various adhesives and provides corresponding information on mixing and application:

TABLE 3.39-A

ADHESIVES USED FOR DUST CONTROL

Adhesive	Water Dilution (Adhesive: Water)	Type of Nozzle	Application Rate Gallons/Acre
Anionic Asphalt Emulsion	7:1	Coarse Spray	1,200
Latex Emulsion	12.5:1	Fine Spray	235
Resin in Water	4:1	Fine Spray	300
Acrylic Emulsion (Non-Traffic)	7:1	Coarse Spray	450
Acrylic Emulsion (Traffic)	3.5:1	Coarse Spray	350

Source: Va. DSWC

6. Stone - Stone can be used to stabilize roads or other areas during construction using crushed stone or coarse gravel (see CONSTRUCTION ROAD STABILIZATION, Std. & Spec. 3.3).

7. Barriers - A board fence, wind fence, sediment fence, or similar barrier can help to control air currents and blowing soil. Place barriers perpendicular to prevailing air currents at intervals of about 15 times the barrier height. Where dust is a known problem, existing windbreak vegetation should be preserved.

8. Calcium Chloride - This chemical may be applied by mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage. Application rates should be strictly in accordance with suppliers' specified rates.

Permanent Methods

1. Permanent Vegetation - The application of PERMANENT SEEDING (see Std. & Spec. 3.32) and saving existing trees and large shrubs can help reduce soil and air movement from construction sites.

2. Stone - Crushed stone or coarse gravel can be used as a permanent cover which will provide control of soil emissions.

TC Energy

Attachment B

Virginia 9VAC25-840-40 Minimum Standards

Virginia Administrative Code
Title 9. Environment
Agency 25. State Water Control Board
Chapter 840. Chapter 840 Erosion and Sediment Control Regulations

9VAC25-840-40. Minimum Standards.

A VESCP must be consistent with the following criteria, techniques and methods:

1. Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

2. During construction of the project, soil stock piles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site.

3. A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that is uniform, mature enough to survive and will inhibit erosion.

4. Sediment basins and traps, perimeter dikes, sediment barriers and other measures intended to trap sediment shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

5. Stabilization measures shall be applied to earthen structures such as dams, dikes and diversions immediately after installation.

6. Sediment traps and sediment basins shall be designed and constructed based upon the total drainage area to be served by the trap or basin.

  a. The minimum storage capacity of a sediment trap shall be 134 cubic yards per acre of drainage area and the trap shall only control drainage areas less than three acres.

  b. Surface runoff from disturbed areas that is comprised of flow from drainage areas greater than or equal to three acres shall be controlled by a sediment basin. The minimum storage capacity of a sediment basin shall be 134 cubic yards per acre of drainage area. The outfall system shall, at a minimum, maintain the structural integrity of the basin during a 25-year storm of 24-hour duration. Runoff coefficients used in runoff calculations shall correspond to a bare earth condition or those conditions expected to exist while the sediment basin is utilized.

7. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion. Slopes that are found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected.

8. Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or slope drain structure.

9. Whenever water seeps from a slope face, adequate drainage or other protection shall be provided.

10. All storm sewer inlets that are made operable during construction shall be protected so that sediment-laden water cannot enter the conveyance system without first being filtered or otherwise treated to remove sediment.

11. Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance

channel and receiving channel.

12. When work in a live watercourse is performed, precautions shall be taken to minimize encroachment, control sediment transport and stabilize the work area to the greatest extent possible during construction. Nonerodible material shall be used for the construction of causeways and cofferdams. Earthen fill may be used for these structures if armored by nonerodible cover materials.

13. When a live watercourse must be crossed by construction vehicles more than twice in any six-month period, a temporary vehicular stream crossing constructed of nonerodible material shall be provided.

14. All applicable federal, state and local requirements pertaining to working in or crossing live watercourses shall be met.

15. The bed and banks of a watercourse shall be stabilized immediately after work in the watercourse is completed.

16. Underground utility lines shall be installed in accordance with the following standards in addition to other applicable criteria:

a. No more than 500 linear feet of trench may be opened at one time.

b. Excavated material shall be placed on the uphill side of trenches.

c. Effluent from dewatering operations shall be filtered or passed through an approved sediment trapping device, or both, and discharged in a manner that does not adversely affect flowing streams or off-site property.

d. Material used for backfilling trenches shall be properly compacted in order to minimize erosion and promote stabilization.

e. Restabilization shall be accomplished in accordance with this chapter.

f. Applicable safety requirements shall be complied with.

17. Where construction vehicle access routes intersect paved or public roads, provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface. Where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day. Sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner. This provision shall apply to individual development lots as well as to larger land-disturbing activities.

18. All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the VESCP authority. Trapped sediment and the disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

19. Properties and waterways downstream from development sites shall be protected from sediment deposition, erosion and damage due to increases in volume, velocity and peak flow rate of stormwater runoff for the stated frequency storm of 24-hour duration in accordance with the following standards and criteria. Stream restoration and relocation projects that incorporate natural channel design concepts are not man-made channels and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels:

a. Concentrated stormwater runoff leaving a development site shall be discharged directly into an adequate natural or man-made receiving channel, pipe or storm sewer system. For those sites where runoff is discharged into a pipe or pipe system, downstream stability analyses at the outfall of the pipe or pipe system shall be performed.

b. Adequacy of all channels and pipes shall be verified in the following manner:

(1) The applicant shall demonstrate that the total drainage area to the point of analysis within the channel is 100 times greater than the contributing drainage area of the project in question;

(2) (a) Natural channels shall be analyzed by the use of a two-year storm to verify that stormwater will not overtop channel banks nor cause erosion of channel bed or banks.

(b) All previously constructed man-made channels shall be analyzed by the use of a 10-year storm to verify that stormwater will not overtop its banks and by the use of a two-year storm to demonstrate that stormwater will not cause erosion of channel bed or banks; and

(c) Pipes and storm sewer systems shall be analyzed by the use of a 10-year storm to verify that stormwater will be contained within the pipe or system.

c. If existing natural receiving channels or previously constructed man-made channels or pipes are not adequate, the applicant shall:

(1) Improve the channels to a condition where a 10-year storm will not overtop the banks and a two-year storm will not cause erosion to the channel, the bed, or the banks;

(2) Improve the pipe or pipe system to a condition where the 10-year storm is contained within the appurtenances;

(3) Develop a site design that will not cause the pre-development peak runoff rate from a two-year storm to increase when runoff outfalls into a natural channel or will not cause the pre-development peak runoff rate from a 10-year storm to increase when runoff outfalls into a man-made channel; or

(4) Provide a combination of channel improvement, stormwater detention or other measures which is satisfactory to the VESCP authority to prevent downstream erosion.

d. The applicant shall provide evidence of permission to make the improvements.

e. All hydrologic analyses shall be based on the existing watershed characteristics and the ultimate development condition of the subject project.

f. If the applicant chooses an option that includes stormwater detention, he shall obtain approval from the VESCP of a plan for maintenance of the detention facilities. The plan shall set forth the maintenance requirements of the facility and the person responsible for performing the maintenance.

g. Outfall from a detention facility shall be discharged to a receiving channel, and energy dissipators shall be placed at the outfall of all detention facilities as necessary to provide a stabilized transition from the facility to the receiving channel.

h. All on-site channels must be verified to be adequate.

i. Increased volumes of sheet flows that may cause erosion or sedimentation on adjacent property shall be diverted to a stable outlet, adequate channel, pipe or pipe system, or to a detention facility.

j. In applying these stormwater management criteria, individual lots or parcels in a residential, commercial or industrial development shall not be considered to be separate development projects. Instead, the development, as a whole, shall be considered to be a single development project. Hydrologic parameters that reflect the ultimate development condition shall be used in all engineering calculations.

k. All measures used to protect properties and waterways shall be employed in a manner which minimizes impacts on the physical, chemical and biological integrity of rivers, streams and other waters of the state.

l. Any plan approved prior to July 1, 2014, that provides for stormwater management that addresses any flow rate capacity and velocity requirements for natural or man-made channels shall satisfy the flow rate capacity and velocity requirements for natural or man-made channels if the practices are designed to (i) detain the water quality volume and to release it over 48 hours; (ii) detain and release over a 24-hour period the expected rainfall resulting from the one year, 24-hour storm; and (iii) reduce the allowable peak flow rate resulting from the 1.5, 2, and 10-year, 24-hour storms to a level that is less than or equal to the peak flow rate from the site assuming it was in a good forested condition, achieved through multiplication of the forested peak flow rate by a reduction factor that is equal to the runoff volume from the site when it was in a good forested condition divided by the runoff volume from the site in its proposed condition, and shall be exempt from any flow rate capacity and velocity requirements for natural or man-made channels as defined in any regulations promulgated pursuant to § 62.1-44.15:54 or 62.1-44.15:65 of the Act.

m. For plans approved on and after July 1, 2014, the flow rate capacity and velocity requirements of § 62.1-44.15:52 A of the Act and this subsection shall be satisfied by compliance with water quantity requirements in the Stormwater Management Act (§ 62.1-44.15:24 et seq. of the Code of Virginia) and attendant regulations, unless such land-disturbing activities (i) are in accordance with provisions for time limits on applicability of approved design criteria in 9VAC25-870-47 or grandfathering in 9VAC25-870-48 of the Virginia Stormwater Management Program (VSMP) Regulation, in which case the flow rate capacity and velocity requirements of § 62.1-44.15:52 A of the Act shall apply, or (ii) are exempt pursuant to § 62.1-44.15:34 C 7 of the Act.

n. Compliance with the water quantity minimum standards set out in 9VAC25-870-66 of the Virginia Stormwater Management Program (VSMP) Regulation shall be deemed to satisfy the requirements of this subdivision 19.

Statutory Authority

§ 62.1-44.15:52 of the Code of Virginia.

Historical Notes

Former 4VAC50-30-40, derived from VR625-02-00 § 4; eff September 13, 1990; amended, Volume 11, Issue 11, eff. March 22, 1995; Volume 29, Issue 04, eff. November 21, 2012; amended and renumbered, Virginia Register Volume 30, Issue 02, eff. October 23, 2013; amended, Virginia Register Volume 31, Issue 24, eff. August 26, 2015; Volume 33, Issue 04, eff. November 17, 2016.

TC Energy

Attachment C

Erosion and Sediment Control Technical Bulletin No. 4

Erosion & Sediment Control Technical Bulletin No. 4

Nutrient Management for Development Sites

PRINCIPLE

This Erosion & Sediment Control Technical Bulletin updates the vegetative cover standards and specifications 3.31 Temporary Seeding, 3.32 Permanent Seeding, 3.33 Sodding, and 3.34 Bermudagrass & Zoysiagrass of the *1992 Virginia Erosion and Sediment Control Handbook*, in accordance with the *1995 Virginia Nutrient Management Standards and Criteria*. Specifically, the vegetation standards and specifications have been updated to reflect that no more than one (1) pound of water soluble nitrogen per 1,000 square feet is to be applied on construction sites in a 30 day period. Attached are one-page updates to the vegetative cover standards and specifications, which provide updated fertilizer and lime rates and the seeding schedules for the different physiographic regions of Virginia.

This document also discusses the need to ensure healthy vegetative growth by promoting a fertile soil as a crucial step in the establishment of vegetation, which can reduce the amount of nutrients (fertilizers) required to maintain a good vegetative cover.

THE IMPORTANCE OF URBAN NUTRIENT MANAGEMENT

Nutrients in urban runoff have been identified as being a significant contributor to the decline of the Chesapeake Bay, as well as Virginia's rivers, lakes, streams and groundwater. Improper timing or over application of plant nutrients is a major cause of non-point source pollution that can result in the impairment of Virginia's groundwater and surface waters. Runoff that carries nitrogen or phosphorus can lead to the increased growth of algae and aquatic weeds, de-oxygenation, and reduced water clarity, which degrades water quality and stresses underwater plant and animal life.

Typical land development practices degrade soil quality and make it difficult to establish lawns and landscaped areas. In the course of development, soil rich in organic material is often stripped, compacted, buried under subsoil, or removed and replaced with shallower depths of lower quality, imported soil or fill material. Properly establishing an appropriate and uniform vegetative cover as quickly as possible on denuded sites plays an extremely important role in reducing erosion and minimizing sedimentation to downstream waterways.

Nutrient management on construction sites helps prevent the pollution and degradation of state waters. Not only are there economic benefits of applying less fertilizer, nutrient reduction can be achieved by applying fertilizer more efficiently. In short, nutrient management is an environmentally and economically sound practice for restoring waters in Virginia and involves the implementation of practices that promote vegetative cover in developing areas while protecting water quality.

ESTABLISHMENT OF VEGETATIVE COVER

Developing a fertile soil is a crucial step in the establishment of vegetation, which can reduce the amount of fertilizer required to maintain good vegetative cover. A fertile soil has the capacity to supply the nutritional needs of the plants being established. Good soil quality characteristics include good soil texture, adequate nutrients available for plant growth, good moisture holding capacity, and the appropriate soil acidity/alkalinity balance (pH). The following is a discussion of the steps needed to ensure good vegetative growth.

1. Soil Tests

Soil tests are extremely important and should be conducted on every site. Soil tests provide specific information on the amounts of phosphorus, potassium, calcium and magnesium available for plant uptake and recommends additional amounts as required. Soil tests are crucial for determining the amount of lime needed to obtain an appropriate soil pH for the vegetation being established. Soil test results include recommendations specific to the site and vegetation being grown. Soil tests recommend the amount of plant nutrients and lime needed to promote and maintain good plant growth. Soil tests may be performed by the Cooperative Extension Service Soil Testing Laboratory at VPI & SU, or by a reputable commercial laboratory. Also note that County Extension offices have soil testing supplies and information.

Soil tests are not used to determine nitrogen needs. Nitrogen is applied based upon established requirements for the plant to be grown, season of growth, and intended use.

2. Surface Roughening

Provide a rough soil surface by stair-step grading, grooving, or tracking the soil to be vegetated or by leaving slopes in a roughened condition by not fine-grading, in accordance with the *1992 Virginia Erosion & Sediment Control Handbook* (Std & Spec 3.29). Seed germination is difficult with compacted soils. Rough, loose soil surfaces helps prevent the loss of lime and fertilizer due to runoff, increases water infiltration, and provides seed coverage, which aids in seed germination.

3. Soil Amendments & Soil Quality

Materials such as sand, vermiculite, peat, and compost may be added to soil to modify texture, improve structure and increase the moisture holding capacity. It is also recommended to conserve existing soil quality by preserving and reapplying topsoil in accordance with the *1992 Virginia Erosion & Sediment Control Handbook* (Std & Spec 3.30). Areas that have been compacted, or where duff or underlying topsoil is removed, should be amended with compost to improve soil quality.

4. Lime

<u>Adjusting the soil pH between 6.25 to 6.5 is extremely important for grass establishment</u>, especially in the acidic soils of Virginia. A soil test is necessary to determine the actual amount of lime required to adjust the soil pH of denuded sites. However, when a soil test has not been performed, apply 2-tons/acre (90 pounds per 1,000 square feet) of pulverized agricultural grade limestone.

5. Fertilizer

Never apply more than 1 pound of water soluble nitrogen per 1,000 square feet within a 30 day period. Nitrogen should be applied based upon established requirements of the plant to be grown, season of growth, and intended use. Establishing a uniform dense vegetative cover with a good root system reduces the potential for pollution by decreasing erosion and runoff, increasing the plants ability for nutrient uptake, and reducing pesticide use. A detailed discussion on fertilizer use is provided in the 'Updated Fertilizer Specifications and Rates for Establishment' section of this bulletin.

6. Incorporation

Incorporate the lime and fertilizer into the top 4 – 6 inches of the soil by discing or by other means. Incorporation reduces the potential nutrient loss due to runoff, as well as significantly increasing the success of establishing a vegetative cover. When surface roughening does not occur prior to the application of lime and fertilizer, 'mix' the lime and fertilizer into the soil, at least 4 inches, by the methods described in the *1992 Virginia Erosion and Sediment Control Handbook* (Std & Spec 3.29).

When incorporation does not occur, and fertilizer and lime is applied directly to a smooth surface, the phosphorus (P_2O_5) application rate must be reduced by half because of the limited contact area with soil and the risk of nutrients being lost in runoff.

7. Seeding

Selection of plants is based on climate, topography, soils, land use and the planting season. The *1992 Virginia Erosion and Sediment Control Handbook* vegetative cover standards and specifications 3.31 Temporary Seeding, 3.32 Permanent Seeding, 3.33 Sodding, and 3.34 Bermudagrass & Zoysiagrass, describe in detail the specifications for plant selection. In addition, attached are one-page updates to the vegetative cover standards and specifications, which provide updated fertilizer and lime rates and the seeding schedules for the different physiographic regions of Virginia.

8. Mulching

The application of mulch to the soil surface, for both temporary and permanent seeding, is one of the most effective means of controlling runoff and erosion on disturbed land. All permanent seeding must be mulched immediately upon completion of seed application. It is especially important to mulch liberally in mid-summer and prior to winter. Mulching prevents erosion, and thereby pollution, by protecting the soil surface and fostering the growth of vegetation by increasing the moisture content and providing insulation from extreme temperatures. The *1992 Virginia Erosion and Sediment Control Handbook* (Std & Spec 3.35) details the mulch specifications and includes a list of the typical materials used to mulch (for example straw, wood chips, and fiber mulch).

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9. Hydroseeding
Hydroseeding is a mechanical method of applying seed, fertilizer, and mulch to land development sites in one step. This method is efficient in providing an immediate cover to denuded sites; however, the surface must be carefully prepared in order for successful seed germination. Hydroseed on rough, loose surfaces only. Roughen the surface prior to application of hydroseeding, per the specification above and in accordance with the *1992 Virginia Erosion & Sediment Control Handbook* (Std & Spec 3.29). Although proper soil pH is crucial in establishing good vegetative cover, lime is usually not included in the hydroseed mix. Therefore, lime should be incorporated into the soil as needed when preparing the site for hydroseeding.

To avoid poor seed germination as a result of seed damage during hydroseeding, it is recommended that if the machinery breaks down from 30 minutes to 2 hours, 50% more seed must be added to the tank. Beyond 2 hours, a full rate of new seed is usually necessary.

UPDATED FERTILIZER SPECIFICATIONS AND RATES FOR ESTABLISHMENT

Plant nutrients should be applied based upon established requirements of the plant to be grown, season of growth, and intended use, as specified in the *1992 Virginia Erosion and Sediment Control Handbook* (Std & Spec 3.31, 3.32, 3.33, and 3.34). The timing and rate of fertilizer application depends on the type of grass. There are basically two types of grasses, warm and cool season grasses. Warm season grasses (Bermuda, Zoysia) are those that go dormant in the winter. Cool season grasses (Fescue, Bluegrass) are those that stay green year round.

1. Recommended Season for Applying Nitrogen Fertilizers
The earliest spring application of nitrogen for **cool season** grasses is six weeks prior to the last average frost date (for example, February 6 for Virginia Beach and March 1 for Roanoke). The latest fall application of nitrogen for **cool season** grasses is six weeks after the first average frost date (for example, December 29 for Virginia Beach and December 1 for Roanoke).

The earliest spring application of nitrogen for **warm season** grasses is the last average frost date for the region (for example, March 20 for Virginia Beach and April 15 for Roanoke). The latest fall application of nitrogen for **warm season** grasses is 30 days prior to the average first frost date for the region (for example, October 15 for Virginia Beach and September 20 for Roanoke).

2. Per Application Rates
Phosphorus (P) and potassium (K) fertilizer requirements should be determined by a soil test. Never apply more than one (1) pound of water soluble nitrogen per 1,000 square feet within a 30 day period. The following table itemizes the fertilization rate revisions to standards and specifications 3.31 Temporary Seeding, 3.32 Permanent Seeding, 3.33 Sodding, and 3.34 Bermudagrass & Zoysiagrass Establishment.

Summary of Fertilizer Specification Revisions for Establishment of Turf

Standards & Specifications		2003 Urban Nutrient Management Technical Bulletin
3.31 Temporary Seeding		**10-10-10** fertilizer applied at a rate of **450** lbs. / acre or **10** lbs. / 1,000 ft^2
3.32 Permanent Seeding	Mixed Grasses & Legumes	**10-20-10** fertilizer applied at a rate of **500** lbs. / acre or **12** lbs. / 1,000 ft^2
	Legume stands only	Apply the equivalent of 100 lbs. of phosphate (P_2O_5) and 100 lbs. of Potash (K_2O) per acre. NO NITROGEN (N)
	Grass stands only	**10-20-10** fertilizer applied at a rate of **500** lbs. / acre or **12** lbs. / 1,000 ft^2
3.33 Sodding		**10-10-10** fertilizer applied at a rate of **450** lbs. / acre or **10** lbs. / 1,000 ft^2. NOTE: For cool season grasses apply fertilizer in fall or spring. For warm season grasses apply the fertilizer in late spring or summer only.
3.34 Bermudagrass & Zoysiagrass Establishment		**10-10-10** fertilizer applied at a rate of **500** lbs. / acre or **12** lbs. / 1,000 ft^2. Apply additional phosphorus and potassium 30-60 days later based on the soil test. Apply an additional equivalent of 1 lb./1,000 ft^2 of nitrogen when the P & K are applied.

3. Using Fertilizer Analysis to Calculate Nitrogen Rates

All fertilizer packages have three numbers present on the package (for example, 10-10-10 or 16-4-8). These three numbers indicate the percentage of nitrogen (N), phosphorus (P_2O_5), and potash (K_2O) present by weight which is called the N-P-K ratio. For example, a 20 pound bag of 10-6-4 is 10 percent nitrogen (2 lb. of N), 6 percent phosphate (1.2 lb. of P_2O_5), and 4 percent potash (0.8 lb. of K_2O) the remaining is inert material to facilitate even application of fertilizer.

The Virginia nutrient management recommendation is to apply no more than 1 lb. of nitrogen per 1,000 square feet within a 30 day period. A fertilization rate of 1 lb. of nitrogen per 1,000 square feet can be obtained for any site by using the fertilizer analyses on the bag and knowing the area of application.

Fertilizer Bag Reads:	Amount to Fertilizer to Apply 1 lb. of nitrogen / 1000 sq.ft.
6-2-0	16.6 lb.
10-10-10	10 lb.
16-4-8	6.2 lb.
20-5-5	5 lb.
22-3-14	4.5 lb.
29-3-7	3.4 lb.

4. Use of Slowly Available Forms of Nitrogen
Fertilizer bags will state the source or category from which the nitrogen is derived. Nitrogen fertilizers have two categories: Water Soluble Nitrogen (i.e., all nitrogen is immediately available); and Slowly Available Nitrogen (i.e., nitrogen is available over an extended period of time). The nitrogen source impacts how grass is fertilized and the rate and timing of application of fertilizer.

Choose a fertilizer that has some amount of Slowly Available Nitrogen (SAN). Slowly available nitrogen fertilizers make nitrogen available a little at a time, the way most grasses need it, which reduces both the potential of excess nutrients in runoff and the leaching potential of excess nutrients into groundwater. Sources of SAN are usually stated on the label. It may be stated as % Water Insoluble Nitrogen (WIN), sulfur-coated urea, natural organic nitrogen or other controlled release materials used to coat the fertilizer. The % WIN is usually stated on the fertilizer container, if the % WIN is not listed, assume that all the nitrogen in the fertilizer is water soluble and immediately available. As a general guideline, if the fertilizer has 50% WIN or less, it should be applied in the same manner as readily available nitrogen. If the fertilizer is 50% WIN or greater, it should be applied as a SAN.

UPDATED FERTILIZER SPECIFICATIONS AND RATES FOR MANAGEMENT

1. Application of Fertilizer for Maintenance
Apply fertilizer when grass is actively growing and can utilize the nutrients. Summer is best for warm season grasses (zoysiagrass and bermudagrass) while the fall months are best for cool season grasses (tall fescue, Kentucky bluegrass, perennial ryegrass).

2. Annual Application Rates

A. When applying 100% Water Soluble Nitrogen sources (those that have all the nitrogen immediately available for plant use), the following rates apply:

- Never apply more than one (1) pound of water soluble nitrogen per 1,000 square feet within a 30 day period
- No more than 3.5 lbs. of nitrogen per 1,000 square feet annually on **cool season** grass.
- No more than 4.0 lbs. of nitrogen per 1,000 square feet annually on **warm season** grass.

B. When applying slowly available nitrogen (SAN, WIN, sulfur-coated urea, natural organic nitrogen or other controlled release materials), total annual nitrogen application rates may be adjusted incrementally by referring to the following figure. The maximum annual nirogen rates when using 50% or greater SAN is as follows:

- No more than 5.0 lbs. of nitrogen per 1,000 square feet annually on **cool season** grass.
- No more than 5.5 lbs. of nitrogen per 1,000 square feet annually on **warm season** grass.

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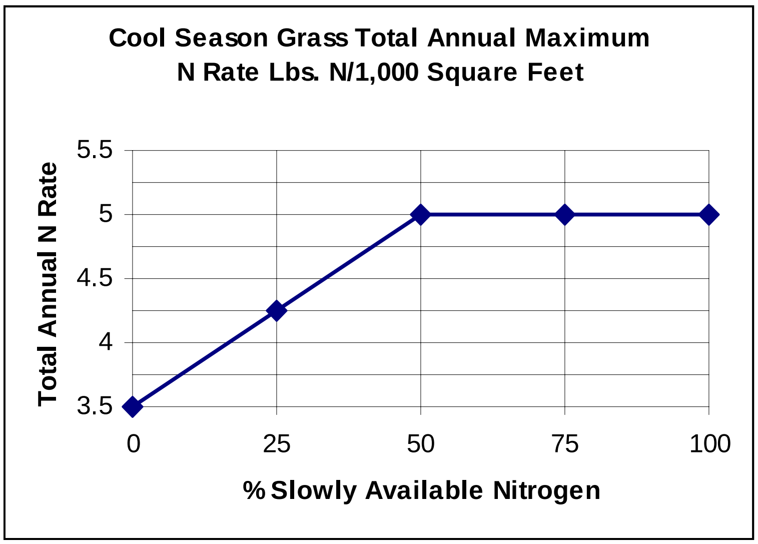
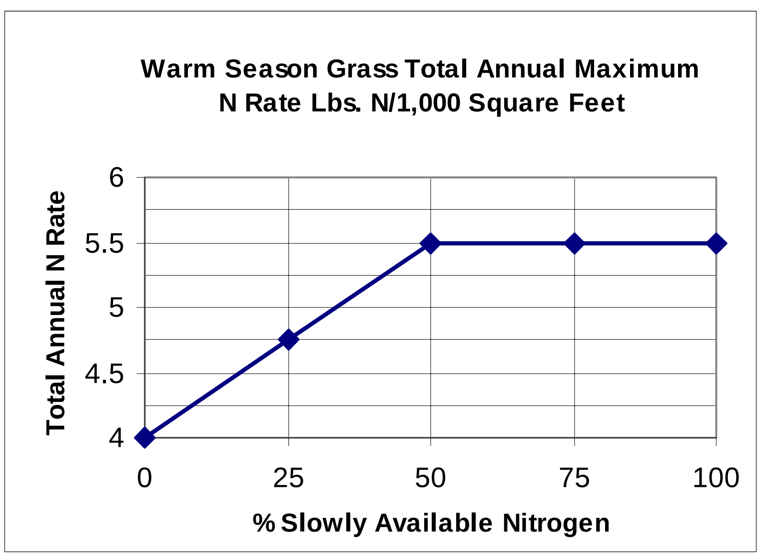




C. When applying maintenance fertilizer on established sod,

Pounds of nitrogen per 1,000 sq. ft. if the fertilizer is less than 50 percent WIN

Month	**Type of Grass**			
	Tall Fescue Perennial Rye	Kentucky Bluegrass	Bermudagrass	Zoysiagrass
September	1	1	0	0
October	1	1	0	0
Early November	0	0	0	0
April	0	0	0	0
May	0-0.5	0-0.05	1	1
June	0	0	1	0
July/August	0	0	0	1
Yearly Lbs. N/1000 sf	2.5	2.5	2	2

Pounds of nitrogen per 1,000 sq. ft. if the fertilizer is more than 50 percent WIN

Month	**Type of Grass**			
	Tall Fescue Perennial Rye	Kentucky Bluegrass	Bermudagrass	Zoysiagrass
August 15	1.5	1.5	0	0
October 1	1.5	1.5	0	0
April	0	0	1.5	1.5
May 15	0	0	0	0
June	0	0	1.5	1.5
Yearly Lbs. N/1000 sf	3	3	3	3

TABLE 3.31-B
(Revised June 2003)
TEMPORARY SEEDING SPECIFICATIONS
QUICK REFERENCE FOR ALL REGIONS

SEED		
APPLICATION DATES	**SPECIES**	**APPLICATION RATES**
Sept. 1 - Feb. 15	50/50 Mix of Annual Ryegrass (lolium multi-florum) & Cereal (Winter) Rye (Secale cereale)	50 -100 (lbs/acre)
Feb. 16 - Apr. 30	Annual Ryegrass (lolium multi-florum)	60 - 100 (lbs/acre)
May 1 - Aug. 31	German Millet	50 (lbs/acre)

FERTILIZER & LIME

- Apply 10-10-10 **fertilizer** at a rate of 450 lbs. / acre (or 10 lbs. / 1,000 sq. ft.)
- Apply **Pulverized Agricultural Limestone** at a rate of 2 tons/acre (or 90 lbs. / 1,000 sq. ft.)

NOTE:
1 - A soil test is necessary to determine the actual amount of lime required to adjust the soil pH of site.
2 - Incorporate the lime and fertilizer into the top 4 – 6 inches of the soil by disking or by other means.

3 - When applying Slowly Available Nitrogen, use rates available in Erosion & Sediment Control Technical Bulletin # 4, 2003 Nutrient Management for Development Sites at http://www.dcr.state.va.us/sw/e&s.htm#pubs

TABLE 3.32-C
(Revised June 2003)
PERMANENT SEEDING SPECIFICATIONS FOR APPALACHIAN/MOUNTAIN AREA

SEED[1]

LAND USE	SPECIES	APPLICATION RATES
Minimum Care Lawn (Commercial or Residential)	Tall Fescue[1] Perennial Ryegrass[2] Kentucky Bluegrass[1]	90-100% 0-10% 0-10% TOTAL: 200-250 lbs.
High-Maintenance Lawn	Minimum of three (3) up to five (5) varieties of Kentucky Bluegrass from approved list for use in Virginia[1]	TOTAL: 125 lbs.
General Slope (3:1 or less)	Tall Fescue[1] Red Top Grass or Creeping Red Fescue Seasonal Nurse Crop[3]	128 lbs. 2 lbs. 20 lbs. TOTAL: 150 lbs.
Low-Maintenance Slope (Steeper than 3:1)	Tall Fescue[1] Red Top Grass or Creeping Red Fescue Seasonal Nurse Crop[3] Crownvetch[4]	108 lbs. 2 lbs. 20 lbs. 20 lbs. TOTAL: 150 lbs.

1 - When selecting varieties of turfgrass, use the Virginia Crop Improvement Association (VCIA) recommended turfgrass variety list. Quality seed will bear a label indicating that they are approved by VCIA. A current turfgrass variety list is available at the local County Extension office or through VCIA at 804-746-4884 or at http://sudan.cses.vt.edu/html/Turf/turf/publications/publications2.html

2 - Perennial Ryegrass will germinate faster and at lower soil temperatures than Tall Fescues, thereby providing cover and erosion resistance for seedbed.

3 - Use seasonal nurse crop in accordance with seeding dates as stated below:

March, April - May 15th …………………….	Annual Rye
May 16th - August 15th …………………….	Foxtail Millet
August 16th - September, October ……….	Annual Rye
November - February ………………………..	Winter Rye

4 - All legume seed must be properly inoculated. If Flatpea is used, increase to 30 lbs/acre. If Weeping Lovegrass is used, include in any slope or low maintenance mixture during warmer seeding periods, increase to 30 -40 lbs/acre.

FERTILIZER & LIME

- Apply 10-20-10 **fertilizer** at a rate of **500** lbs. / acre (or 12 lbs. / 1,000 sq. ft.)
- Apply **Pulverized Agricultural Limestone** at a rate of 2 tons/acre (or 90 lbs. / 1,000 sq. ft.)

NOTE:
- A soil test is necessary to determine the actual amount of lime required to adjust the soil pH of site.
- Incorporate the lime and fertilizer into the top 4 – 6 inches of the soil by disking or by other means.
- When applying Slowly Available Nitrogen, use rates available in Erosion & Sediment Control Technical Bulletin # 4, 2003 Nutrient Management for Development Sites at http://www.dcr.state.va.us/sw/e&s.htm#pubs

TABLE 3.32-D
(Revised June 2003)
PERMANENT SEEDING SPECIFICATIONS FOR PIEDMONT AREA

SEED[1]		
LAND USE	**SPECIES**	**APPLICATION PER ACRE**
Minimum Care Lawn (Commercial or Residential)	Tall Fescue[1] Perennial Ryegrass Kentucky Bluegrass[1]	95-100% 0-5% 0-5% TOTAL: 175-200 lbs.
High-Maintenance Lawn	Tall Fescue[1]	TOTAL: 200-250 lbs.
General Slope (3:1 or less)	Tall Fescue[1] Red Top Grass or Creeping Red Fescue Seasonal Nurse Crop[2]	128 lbs. 2 lbs. 20 lbs. TOTAL: 150 lbs.
Low-Maintenance Slope (Steeper than 3:1)	Tall Fescue[1] Red Top Grass or Creeping Red Fescue Seasonal Nurse Crop[2] Crownvetch[3]	108 lbs. 2 lbs. 20 lbs. 20 lbs. TOTAL: 150 lbs.

1 - When selecting varieties of turfgrass, use the Virginia Crop Improvement Association (VCIA) recommended turfgrass variety list. Quality seed will bear a label indicating that they are approved by VCIA. A current turfgrass variety list is available at the local County Extension office or through VCIA at 804-746-4884 or at http://sudan.cses.vt.edu/html/Turf/turf/publications/publications2.html

2 - Use seasonal nurse crop in accordance with seeding dates as stated below:

February 16th - April …….…………..……..	Annual Rye
May 1st - August 15th ………..……………	Foxtail Millet
August 16th - October ……	Annual Rye
November - February 15th …………….……	Winter Rye

3 - Substitute Sericea lespedeza for Crownvetch east of Farmville, VA (May through September use hulled seed, all other periods, use unhulled Sericea). If Flatpea is used, increase rate to 30 lbs./acre. If Weeping Lovegrass is used, include in any slope or low maintenance mixture during warmer seeding periods, increase to 30 -40

FERTILIZER & LIME

- Apply 10-20-10 **fertilizer** at a rate of **500** lbs. / acre (or 12 lbs. / 1,000 sq. ft.)
- Apply **Pulverized Agricultural Limestone** at a rate of 2 tons/acre (or 90 lbs. / 1,000 sq. ft.)

NOTE:
- A soil test is necessary to determine the actual amount of lime required to adjust the soil pH of site.
- Incorporate the lime and fertilizer into the top 4 – 6 inches of the soil by disking or by other means.
- When applying Slowly Available Nitrogen, use rates available in Erosion & Sediment Control Technical Bulletin # 4, 2003 Nutrient Management for Development Sites at http://www.dcr.state.va.us/sw/e&s.htm#pubs

TABLE 3.32-E
(Revised June 2003)
PERMANENT SEEDING SPECIFICATIONS FOR COASTAL PLAIN AREA

SEED[1]

LAND USE	SPECIES	APPLICATION RATES
Minimum Care Lawn (Commercial or Residential)	Tall Fescue[1] **or** Bermudagrass[1]	175 - 200 lbs. 75 lbs.
High-Maintenance Lawn	Tall Fescue[1] **or** Bermudagrass[1] (seed) **or** Bermudagrass[1] (by other vegetative establishment method, see Std. & Spec. 3.34)	200-250 lbs. 40 lbs. (unhulled) 30 lbs. (hulled)
General Slope (3:1 or less)	Tall Fescue[1] Red Top Grass or Creeping Red Fescue Seasonal Nurse Crop[2]	128 lbs. 2 lbs. 20 lbs. TOTAL: 150 lbs.
Low-Maintenance Slope (Steeper than 3:1)	Tall Fescue[1] Bermudagrass[1] Red Top Grass or Creeping Red Fescue Seasonal Nurse Crop[2] Sericea Lespedeza[3]	93-108 lbs. 0-15 lbs. 2 lbs. 20 lbs. 20 lbs. TOTAL: 150 lbs.

1 - When selecting varieties of turfgrass, use the Virginia Crop Improvement Association (VCIA) recommended turfgrass variety list. Quality seed will bear a label indicating that they are approved by VCIA. A current turfgrass variety list is available at the local County Extension office or through VCIA at 804-746-4884 or at http://sudan.cses.vt.edu/html/Turf/turf/publications/publications2.html

2 - Use seasonal nurse crop in accordance with seeding dates as stated below:

February, March - April ..……………..……..	Annual Rye
May 1st - August ……………..……………	Foxtail Millet
September, October - November 15th ……	Annual Rye
November 16th - January …………………..…..	Winter Rye

3 - May through October, use hulled seed. All other seeding periods, use unhulled seed. If Weeping Lovegrass is used, include in any slope or low maintenance mixture during warmer seeding periods, increase to 30 -40 lbs/acre.

FERTILIZER & LIME

- Apply 10-20-10 **fertilizer** at a rate of **500** lbs. / acre (or 12 lbs. / 1,000 sq. ft.)
- Apply **Pulverized Agricultural Limestone** at a rate of 2 tons/acre (or 90 lbs. / 1,000 sq. ft.)

NOTE:
- A soil test is necessary to determine the actual amount of lime required to adjust the soil pH of site.
- Incorporate the lime and fertilizer into the top 4 – 6 inches of the soil by disking or by other means.
- When applying Slowly Available Nitrogen, use rates available in Erosion & Sediment Control Technical Bulletin # 4, 2003 Nutrient Management for Development Sites at http://www.dcr.state.va.us/sw/e&s.htm#pubs

TC Energy

Attachment D

Additional Non-VESCH Erosion and Sediment Control Specifications

Table of Contents

Note: Page numbers are not present as the details in Attachment D came from varying sources, and only some of the original documents contained page numbers. Details in Attachment D are separated by flysheets instead.

Attachment D

Belted Silt Retention Fence

SILT-SAVER, INC.

Manufacturer's Installation Instructions – Belted Silt Retention Fence (BSRF)
Silt Fence System Designed for the Control of Sheet Flow
Priority 1-Green Band

Product Description: The BSRF is a 36" wide, non-woven spun-bond polyester fabric with an internal scrim. The system utilizes wood stakes and a specific method of attachment. (See Installation Specifications) The BSRF, when installed as specified, produces a proven system with superior filtering capabilities in slurry conditions.

Purpose: The BSRF shall be used as a vertical interceptor of sediment transported by overland flow on construction sites. The Belted Silt Retention Fence (BSRF) has been designed and tested as a silt fence ***system.***

Supporting Documents: The BSRF silt fence system underwent comprehensive testing by the University of Georgia. The study describes the proven performance and efficiency of the BSRF and provides documentation of its superior attributes. As evidenced by the study, the BSRF meets the 75% filtration efficiency requirements of the Federal Highway Administration. The University of Georgia study, in its entirety, may be found on the following websites: www.asabe.org or www.siltsaver.com.

Installation Specifications: The method of installation for the BSRF is an integral part of the system and is unlike any other installation practices. Our specifically designed process includes wood (oak) stakes and wood bonding strips at four (4') foot intervals. Four foot stakes are driven to a depth which allows 24" of fabric to be above ground. The fabric is then stretched along the ***inside*** perimeter of the stakes, pulled tightly and held in place with bonding strips. The bonding strips (typically 1" x 3/8" x 24") are attached to the stake with 1" x 1 ¼ " staples. Five staples are used to secure the fabric in place against the 1 ¼" x 1 ¾" oak posts. This installation bonds the fabric and support system (scrim) to the vertical support post. The remaining fabric is now tucked into the trench forming a "J" and when filled with dirt creates a "ground bite". With its firm attachment to each post, the load is now spread to the total linear strength of all the posts within the system. (See installation diagram – page 3) **Any variance from the material specifications installation requirements may alter the performance of this product.**

BSRF fabric should be purchased in continuous rolls and cut to the length of the barrier to avoid joints. When joints are necessary, use an 18" – 24" overlap as show in the detail on page 2.

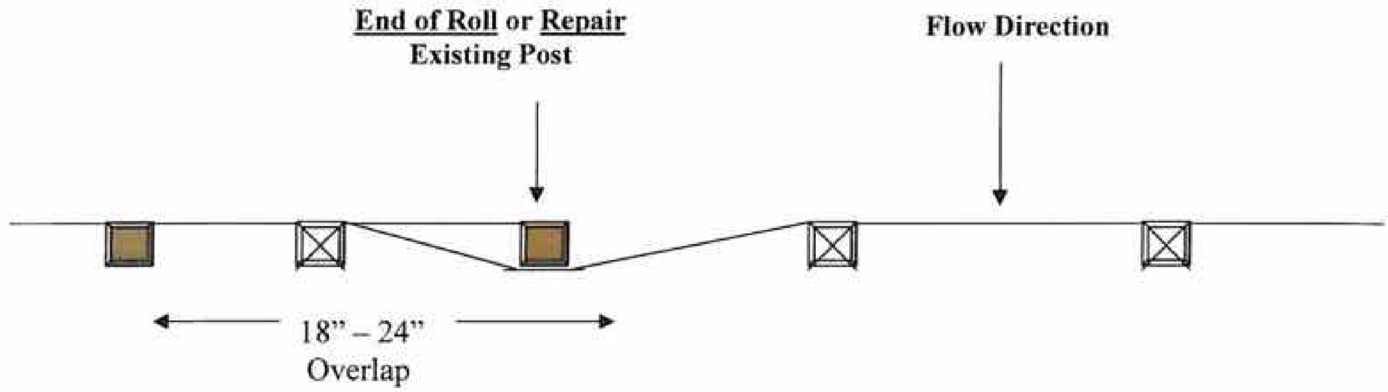
This product is available pre-staked to these specifications from the manufacturer.

Design Limitations: Designed for control of ***sheet flow,*** silt fence shall not be installed across streams, ditches, waterways, or anywhere there is ***concentrated flow.*** Silt fence shall not be placed around ***storm water inlets*** which are designed to receive ***concentrated flow.***

Maintenance: Silt fence should be inspected at the end of each work day and particularly after each rainfall event. Accumulated sediment should be removed when it reaches half the height of the fence to prevent failures. Remove the fence and the accumulated sediment and stabilize the exposed area when the project is finished.

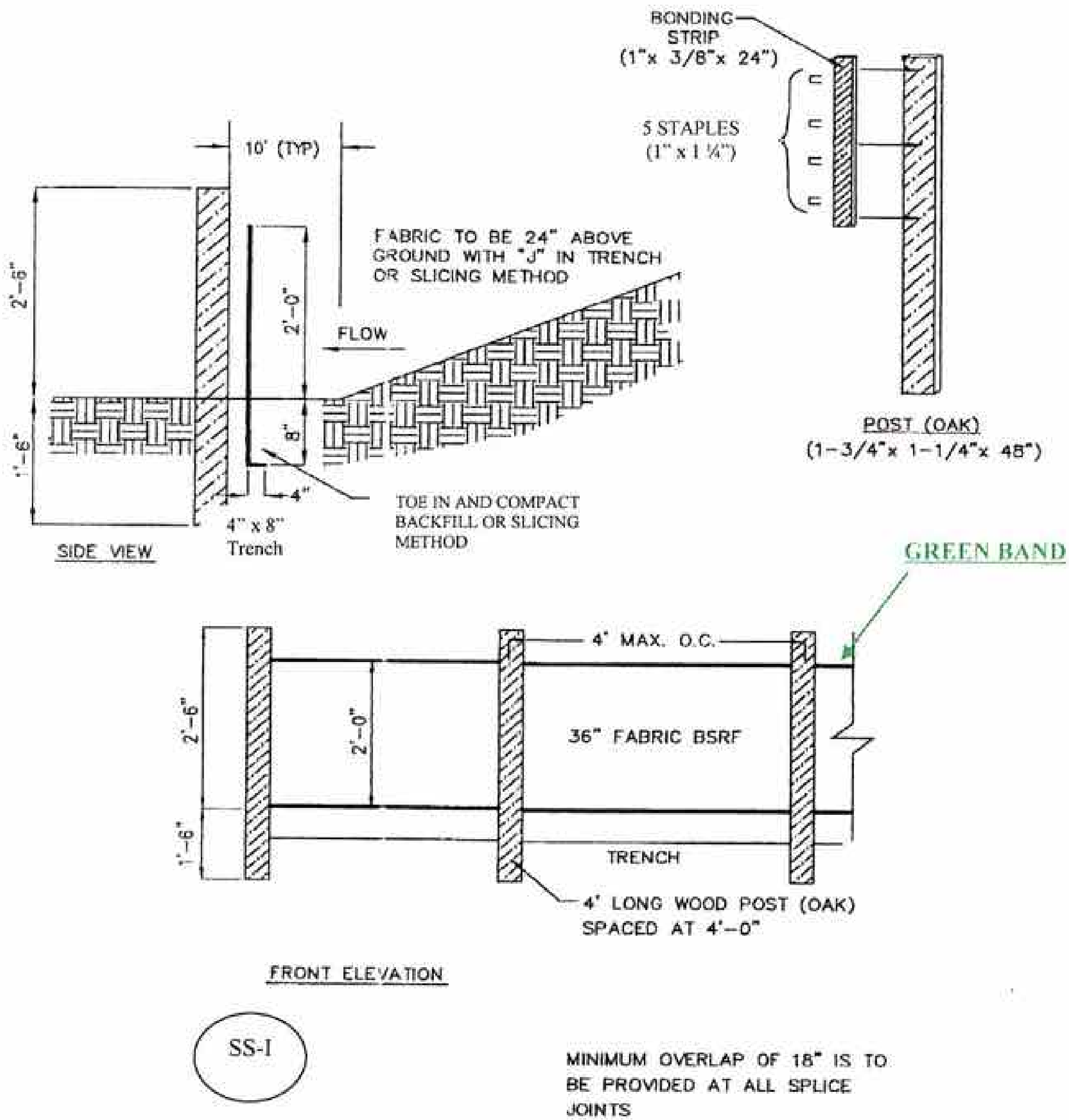
Repair: See detail – page 2.

Longevity: The life of this product is determined at the point in which it is no longer effective or needed to do the job for which it was designed. (Approximately one (1) year)



Top View – Not To Scale

SILT-SAVER, INC.



MINIMUM OVERLAP OF 18" IS TO BE PROVIDED AT ALL SPLICE JOINTS

BELTED SILT RETENTION FENCE (BSRF)

SILT-SAVER, INC.
• 1094 CULPEPPER DRIVE • CONYERS, GA 30094 •
• OFFICE 770-388-7818 • FAX 770-388-7640 • TOLL FREE 1-888-382-SILT (7458) • WEBSITE WWW.SILTSAVER.COM •

TC Energy

Attachment D

Flexterra HP-FGM

Flexterra® HP-FGM™

High Performance Flexible Growth Medium

Solutions for your Environment™

GREEN DESIGN ENGINEERING™
EARTH-FRIENDLY SOLUTIONS FOR SUSTAINABLE RESULTS™

Description

Flexterra® HP-FGM™ is a fully biodegradable, High Performance-Flexible Growth Medium (HP-FGM) composed of 100% recycled and Thermally Refined™ wood fibers, crimped interlocking biodegradable fibers, micro-pore granules, naturally derived cross-linked biopolymers and water absorbents. The HP-FGM is phytosanitized, free from weed seeds, free from plastic netting, requires no curing period and upon application forms an intimate bond with the soil surface to create a continuous, porous, absorbent and flexible erosion resistant blanket that allows for rapid germination and accelerated plant growth.

Recommended Applications

- Erosion control for slopes ranging from mild to severe (≤0.25H:1V)
- Rough graded slopes
- Superior performance over rolled erosion control blankets
- Enhancement of vegetation establishment
- Ideal infill material to create the GreenArmor™ System

Technical Data

Physical Properties*	**Test Method**	**Units**	**Tested Value**
Mass/Unit Area	ASTM D6566[1]	g/m^2 (oz/yd^2)	≥ 390 (11.6)
Thickness	ASTM D6525[1]	mm (in)	≥ 5.6 (0.22)
Ground Cover	ASTM D6567[1]	%	≥ 99
Water Holding Capacity	ASTM D7367	%	≥ 1,700
Material Color	Observed	n/a	Green
Performance Properties*	**Test Method**	**Units**	**Tested Value**
Cover Factor[2]	Large Scale[4]	n/a	≤ 0.01
Percent Effectiveness[3]	Large Scale[4]	%	≥ 99
Cure Time	Observed	hours	0 - 2
Vegetation Establishment	ASTM D7322[1]	%	≥ 800
Functional Longevity[5]	ASTM D5338	months	≤ 18
Environmental Properties*	**Test Method**	**Units**	**Tested Value**
Ecotoxicity	EPA 2021.0	%	48-hr LC_{50} > 100%
Effluent Turbidity	Large Scale[4]	NTU	< 250
Biodegradability	ASTM D5338	n/a	Yes

Product Composition	**Typical Value**
Thermally Processed Wood Fiber[6] (within a pressurized vessel)	80 %
Wetting Agents-including high-viscosity colloidal polysaccharides, cross-linked biopolymers, and water absorbents	10 %
Crimped, Biodegradable Interlocking Fibers	5 %
Micro-Pore Granules	5 %

* When uniformly applied at a rate of 3500 pounds per acre (3900 kilograms/hectare) under laboratory conditions. 1. ASTM test methods developed for Rolled Erosion Control Products that have been modified to accommodate Hydraulic Erosion Control Products. 2. Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface. 3. % Effectiveness = One minus Cover Factor multiplied by 100%. 4. Large scale testing conducted at Utah Water Research Laboratory. For specific testing information please contact a Profile technical service representative at 866-325-6262 or +1-847-215-1144. 5. Functional Longevity is the estimated time period, based upon field observations, that a material can be anticipated to provide erosion control and agronomic benefits as influenced by composition, as well as site-specific conditions, including; but not limited to – temperature, moisture, light conditions, soils, biological activity, vegetative establishment and other environmental factors. 6. Heated to a temperature greater than 380 degrees Fahrenheit (193 degrees Celsius) for 5 minutes at a pressure greater than 50 psi (345 kPa) in order to be Thermally Refined™/Processed and to achieve phyto-sanitization.

Packaging Data

Properties	**Test Method**	**Units**	**Nominal Value**
Bag Weight	Scale	kg (lb)	22.7 (50)
Bags per Pallet	Observed	#	40

UV and weather-resistant plastic bags. Pallets are weather-proof stretch wrapped with UV resistant pallet cover.

Profile Products
750 Lake Cook Road, Ste. 440
Buffalo Grove, IL 60089
800-508-8681 or +1-847-215-1144
www.profileproducts.com

Profile
Solutions for your Environment™

Flexterra® HP-FGM®

High Performance Erosion Control

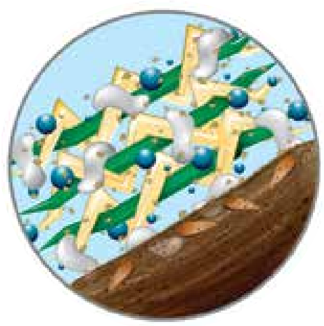
Absolutely The Most Effective Erosion Control Medium Available.

When your site demands the most from your erosion control solution, you need to demand Flexterra® High Performance-Flexible Growth Medium® (HP-FGM®) — the pinnacle of the erosion control industry. Fine grading and extensive soil preparation are unnecessary, allowing you to apply the product for immediate protection and superior performance at reduced overall costs.

Flexterra HP-FGM Delivers:

- The highest germination and vegetative establishment when compared to any rolled blanket or other hydraulically applied mulch available
- Greater than 99% erosion control effectiveness immediately upon application
- 100% biodegradability
- Safe for even the most sensitive environments because it's non-toxic

HP Technology: Greener By Design

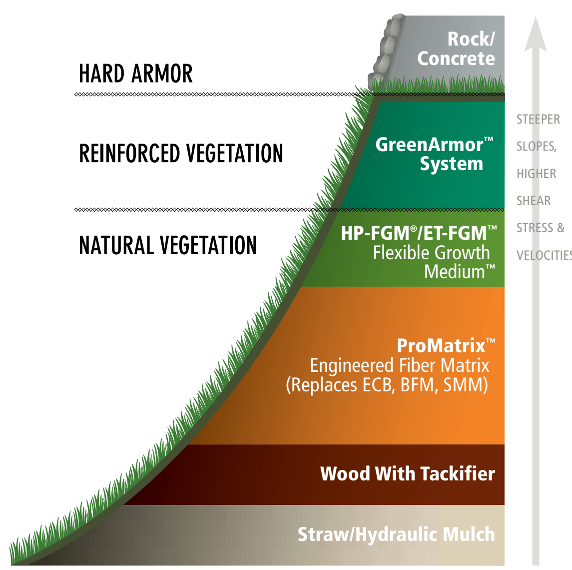


100% recycled, Thermally Refined® virgin wood fibers produce the highest yield and coverage per unit weight and are phyto-sanitized, eliminating weed seeds and pathogens

100% biodegradable, interlocking fibers increase mechanical bonding of the matrix to provide immediate performance upon installation

100% non-toxic biopolymers and water absorbents enhance erosion resistance and vegetative establishment

Revolutionary patented Micro-Pore particles optimize water and nutrient retention



Flexterra® HP-FGM® Technical Data:

	TEST METHOD	UNITS	TESTED VALUE
PHYSICAL PROPERTIES*			
Mass/Unit Area	ASTM D6566[1]	g/m² (oz/yd²)	≥ 390 (11.6)
Thickness	ASTM D6525[1]	mm (in)	≥ 5.6 (0.22)
Ground Cover	ASTM D6567[1]	%	≥ 99
Water-Holding Capacity	ASTM D7367	%	≥ 1,700
Material Color	Observed	n/a	Green
ENVIRONMENTAL PROPERTIES*			
Biodegradability	ASTM D5338	n/a	Yes
Ecotoxicity	EPA 2021.0	%	48-hr LC_{50} > 100%
Effluent Turbidity	Large Scale[5]	NTU	< 250
PERFORMANCE PROPERTIES*			
Cover Factor[2]	Large Scale[5]	n/a	≤ 0.01
Percent Effectiveness[3]	Large Scale[5]	%	≥ 99
Functional Longevity[4]	ASTM D5338	months	≤ 18
Cure Time	Observed	hours	0-2
Vegetation Establishment	ASTM D7322[1]	%	≥ 800
PRODUCT COMPOSITION			**TYPICAL VALUE**
Thermally Processed[6] (within a pressurized vessel) 100% Recycled Virgin Wood Fibers			80%
Wetting agents (including high-viscosity colloidal polysaccharides, cross-linked biopolymers, and water absorbents)			10%
Crimped Biodegradable Interlocking Fibers			5%
Micro-Pore Granules			5%

* *When uniformly applied at a rate of 3,500 lb/ac (3,920 kg/ha) under laboratory conditions.*

1. *ASTM test methods developed for Rolled Erosion Control Products that have been modified to accommodate Hydraulic Erosion Control Products.*
2. *Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface.*
3. *Percent Effectiveness = One minus Cover Factor multiplied by 100%.*
4. *Functional Longevity is the estimated time period, based upon field observations, that a material can be anticipated to provide erosion control and agronomic benefits as influenced by composition, as well as site-specific conditions, including; but not limited to—temperature, moisture and light conditions, soils, biological activity, vegetative establishment and other environmental factors.*
5. *Large Scale testing conducted at Utah Water Research Laboratory. For specific testing information please contact a Profile technical service representative at 800-508-8681 (US and Canada) or +1-847-215-1144 (International).*
6. *Heated to a temperature greater than 193 degrees C (380 degrees F) for 5 minutes at a pressure greater than 345 kPa (50 psi) in order to be Thermally Refined®/Processed and to achieve phyto-sanitization.*

SETTING THE BAR EVEN HIGHER

Better Erosion Control—Flexterra® HP-FGM® immediately bonds to the soil surface. Its flexible yet stable matrix retains > 99% of soil, vastly reducing turbidity of runoff for up to 18 months.

Greater Seed Germination and Growth—Flexterra HP-FGM delivers the highest growth establishment in the market, ≥ 800% via ASTM D7322, due to a combination of optimized water and nutrient retention.

Safer for the Environment—Unlike rolled erosion control blankets, Flexterra HP-FGM has no nets or threads to endanger wildlife. It uses 100% biodegradable crimped interlocking fibers and 100% recycled and phyto-sanitized wood fibers. Flexterra HP-FGM is 100% safe in even the most sensitive environments.

Earth-Friendly and Sustainable Results—Flexterra HP-FGM is a result of Profile's Green Design Engineering™, creating cost-effective and environmentally superior solutions through the design, manufacture and application of sustainable erosion control and vegetation establishment technologies.

GREEN DESIGN ENGINEERING™
EARTH-FRIENDLY SOLUTIONS FOR SUSTAINABLE RESULTS™

Green Design Engineering™ is a holistic approach that combines agronomic and engineering expertise with advanced technologies to provide cost-effective and earth-friendly solutions. Profile strives to deliver Green Design Engineering across our team of consulting professionals, innovative products and educational resources.

PS³
PROFILE SOIL SOLUTIONS SOFTWARE

PS³ is a free, comprehensive 24/7 online resource you can use to design a project and select the right products that address both the physical and agronomic needs of your site. It will help you develop holistic, sustainable solutions for cost-effective erosion control, vegetation establishment and subsequent reductions in sediment and other pollutants from leaving disturbed sites. Because good plans start with the soil, PS³ offers free soil testing to ensure this critical step is considered. To access the site, design your project and take advantage of a free soil analysis, visit **profileps3.com**.

Profile®
Solutions for your Environment™

For technical information or distribution,
please call 800-508-8681.
For customer service, call 800-366-1180.
For warranty information,
visit profileproducts.com.
750 W. Lake Cook Road • Suite 440
Buffalo Grove, IL 60089
profileproducts.com

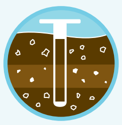
High Performance Erosion Control

Flexterra® HP-FGM™

Profile®

Profile's 5 Fundamentals are the Foundation to Sustainable Vegetation

Establishing sustainable vegetation and receiving the earliest possible Notice of Termination (NOT) are the goals of every project. Profile's 5 Fundamentals are the surest way to get you there. Picking the right erosion control material like Flexterra® HP-FGM™ is just one of the 5 steps.



1. Assess and Create Optimal Soil Conditions

Soil testing provides essential information to determine what soil amendments, if any, are required to assure a more favorable growing environment for faster, more complete vegetative growth and sustainable establishment.

2. Pick the Right Plant Species

It is essential to select plant species that are adapted to the site conditions.

3. Select the Correct Erosion Control Material

The right cover protects both seed and soil, and facilitates growth. Flexterra HP-FGM is unsurpassed in delivering outstanding performance.

4. Ensure Proper Installation

Products must be installed in accordance with manufacturer recommendations to maximize their performance.

5. Follow-up Inspections and Maintenance Practices

Continual monitoring ensures all site compliance issues are being addressed. Maintenance may be required to mitigate unexpected challenges.

Profile provides valuable assistance for each of these Fundamentals 24/7— beginning with FREE soil testing. Visit profileps3.com.

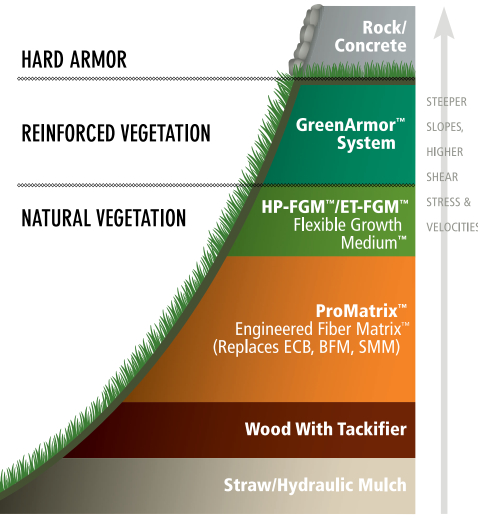
FLEXTERRA® HP-FGM™

Absolutely the Most Effective Erosion Control Medium Available

Flexterra® HP-FGM™ stands alone as the ultimate erosion control and revegetation product. Fine grading and extensive soil preparation are unnecessary, allowing you to apply the product for immediate protection and superior performance at reduced overall costs.

Flexterra HP-FGM Delivers:

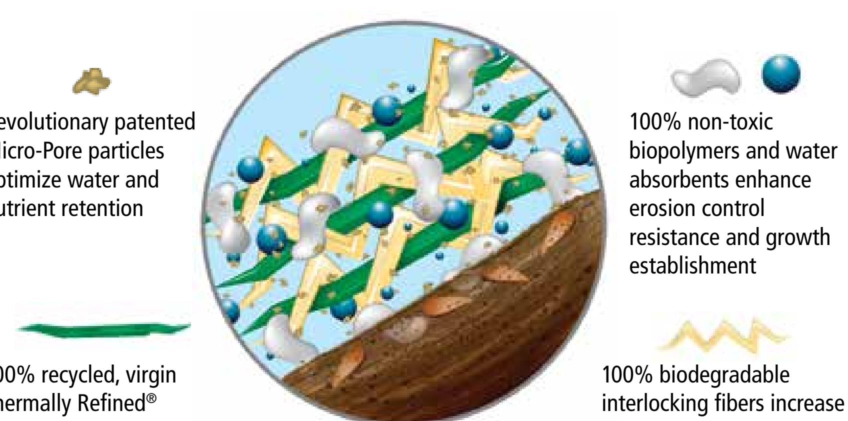
- The highest germination and growth establishment of any rolled or other hydraulically applied erosion control product available
- Greater than 99% erosion control effectiveness immediately upon application
- 100% biodegradable
- Non-toxic and safe for even the most sensitive environments



Superior erosion control across Profile's spectrum of products ensures reliable, sustainable solutions for slopes, channels, shorelines, water management projects, pipeline restorations, waste and fly ash containment sites, fine turf areas and other environmentally sensitive sites.

Patented Technologies and Greener Components Deliver Unmatched Performance

Flexterra HP-FGM combines both chemical and mechanical bonding techniques to lock the engineered medium in place and promote accelerated germination with minimal soil loss. Greener from the inside out, here's what makes it work so well:



Revolutionary patented Micro-Pore particles optimize water and nutrient retention

100% non-toxic biopolymers and water absorbents enhance erosion control resistance and growth establishment

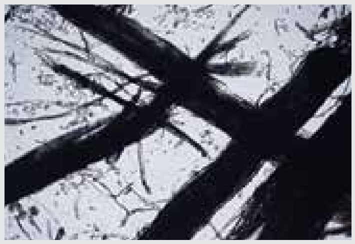
100% recycled, virgin Thermally Refined® wood fibers produce the highest yield and coverage per unit weight, and are phyto-sanitized, eliminating weed seeds and pathogens

100% biodegradable interlocking fibers increase mechanical bonding of the matrix to provide immediate performance upon installation

A Closer Look at Micro-Pore Particles and Thermally Refined® Wood Fibers

- Micro-Pore particles capture and hold moisture and nutrients, reduce soil surface evaporation and improve oxygen exchange, which all contribute to faster, more uniform vegetation establishment.
- Micro-Pore particles also increase bond strength of the flexible growth medium, resulting in greater resistance to raindrop impact and sheet flow.

Fibers magnified 45 times by independent lab specializing in fiber analysis.

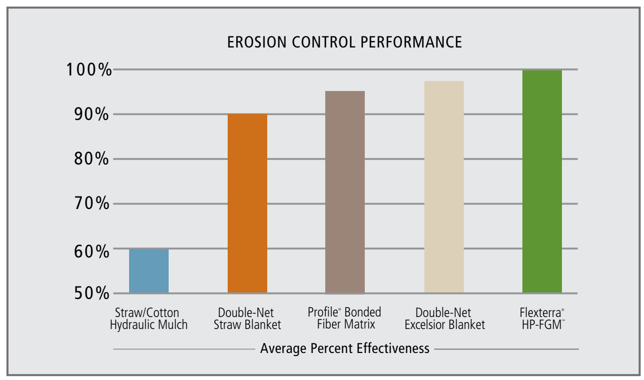


Inferior wood fibers magnified 45 times.

- 100% recycled, Thermally Refined® virgin wood chips create fine, long and highly absorbent fibers that deliver superior yield, coverage and water-holding capacity.
- Competitive refining technologies develop inferior fibers that require more bales to achieve the coverage of Profile's Thermally Refined wood fiber matrices. Additionally, claims that competitive mulches save or use less water during application just don't hold water.

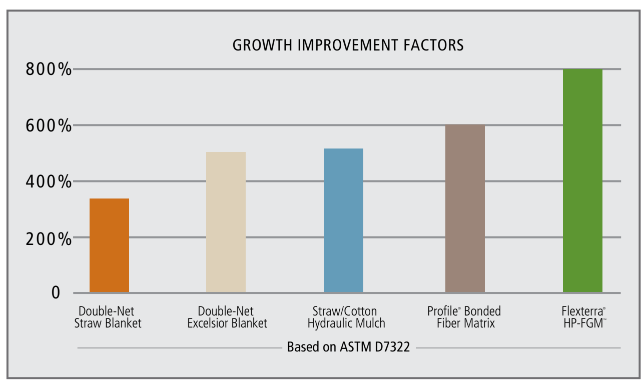
Nothing Keeps More Soil On Site

Flexterra® HP-FGM™ has demonstrated nearly perfect erosion control performance — even on slopes as severe as 0.25H:1V. In addition to minimizing soil loss, the turbidity of runoff is greatly reduced. In large scale testing, Flexterra HP-FGM reduced effluent turbidity of sandy loam soils to less than 250 Nephelometric Turbidity Units (NTUs).



Establishes Vegetation More Reliably

Quicker and complete establishment is the key to long-term erosion control. Flexterra HP-FGM has recorded the highest growth establishment rating of any erosion control product in independent laboratory testing using standard test method ASTM D7322.

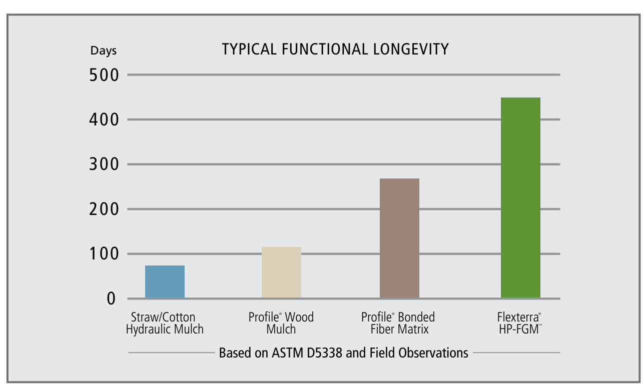


The First Erosion Control Product to Offer Documented Functional Longevity

ASTM D5338 testing protocol confirms Flexterra HP-FGM's observed functional longevity of up to 18 months. Flexterra HP-FGM is proven to last longer than other hydraulically applied erosion control products.

Long-lasting Flexterra HP-FGM is designed to:

- **Provide protection on bare soil over periods of dormancy;** assures that when more optimal growing conditions arrive, the seed and nutrients are still in place and in an environment conducive to rapid germination and emergence.
- **Increase survivability of plants;** exceptional water retention nurtures vegetation to better withstand environmental stress.
- **Accommodate a broad range of vegetative species;** safeguards and helps to cultivate even the slowest establishing species.



Flexterra® HP-FGM™ Technical Data:

	TEST METHOD	UNITS	TESTED VALUE
PHYSICAL PROPERTIES*			
Mass/Unit Area	ASTM D6566[1]	g/m² (oz/yd²)	≥ 390 (11.6)
Thickness	ASTM D6525[1]	mm (in)	≥ 5.6 (0.22)
Ground Cover	ASTM D6567[1]	%	≥ 99
Water-Holding Capacity	ASTM D7367	%	≥ 1,700
Material Color	Observed	n/a	Green
ENVIRONMENTAL PROPERTIES*			
Biodegradability	ASTM D5338	n/a	Yes
Ecotoxicity	EPA 2021.0	%	48-hr LC_{50} > 100%
Effluent Turbidity	Large Scale[5]	NTU	< 250
PERFORMANCE PROPERTIES*			
Cover Factor[2]	Large Scale[5]	n/a	≤ 0.01
Percent Effectiveness[3]	Large Scale[5]	%	≥ 99
Functional Longevity[4]	ASTM D5338	months	≤ 18
Cure Time	Observed	hours	0-2
Vegetation Establishment	ASTM D7322[1]	%	≥ 800
PRODUCT COMPOSITION			**TYPICAL VALUE**
Thermally Processed[6] (within a pressurized vessel) 100% Recycled Virgin Wood Fibers			80%
Wetting agents (including high-viscosity colloidal polysaccharides, cross-linked biopolymers, and water absorbents)			10%
Crimped Biodegradable Interlocking Fibers			5%
Micro-Pore Granules			5%

** When uniformly applied at a rate of 3,500 lb/ac (3,940 kg/ha) under laboratory conditions.*

1. *ASTM test methods developed for Rolled Erosion Control Products that have been modified to accommodate Hydraulic Erosion Control Products.*
2. *Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface.*
3. *Percent Effectiveness = One minus Cover Factor multiplied by 100%.*
4. *Functional Longevity is the estimated time period, based upon field observations, that a material can be anticipated to provide erosion control and agronomic benefits as influenced by composition, as well as site-specific conditions, including; but not limited to—temperature, moisture and light conditions, soils, biological activity, vegetative establishment and other environmental factors.*
5. *Large Scale testing conducted at Utah Water Research Laboratory. For specific testing information, please contact a Profile technical service representative at 800-508-8681 (US and Canada) or International - +1-847-215-1144.*
6. *Heated to a temperature greater than 380 degrees Fahrenheit (193 degrees Celsius) for 5 minutes at a pressure greater than 50 psi (345 kPa).*

GREEN DESIGN ENGINEERING™
EARTH-FRIENDLY SOLUTIONS FOR SUSTAINABLE RESULTS™

Green Design Engineering™ is a holistic approach, combining environmentally beneficial design and ecologically sound products with agronomic and erosion control expertise, to provide the most effective, customized and cost-efficient solutions for erosion control and vegetative establishment.

PS³ PROFILE SOIL SOLUTIONS SOFTWARE

PS³, Profile's unique online project design and management software, is the best place to start applying The 5 Fundamentals™ to your next project. The process begins with a FREE soil test, and walks you through every Fundamental. It's the only program of its kind that integrates and compares a variety of technologies to your specific project parameters, and provides complete documentation including product specifications, installation guidelines, CAD details and other pertinent technical information. Get started by visiting **ProfilePS3.com**.

Profile® Solutions for your Environment™

PROFILE Products LLC
750 W. Lake Cook Rd • Suite 440
Buffalo Grove, IL 60089 • 800-508-8681
profileproducts.com

IECA Cornerstone Member

Section 31 25 14.13 – Hydraulically-Applied Erosion Control: High Performance-Flexible Growth Medium™

GENERAL

1.01 SUMMARY

A. This section specifies the hydraulically-applied erosion control product Flexterra® High Performance-Flexible Growth Medium™ (HP-FGM™). Flexterra HP-FGM is 100% biodegradable, made in the United States and composed of 100% recycled, thermally refined (within a pressurized vessel) virgin wood fibers, crimped interlocking biodegradable fibers, mineral activators, and wetting agents (including high-viscosity colloidal polysaccharides, cross-linked biopolymers and water absorbents). The HP-FGM is phytosanitized, free from plastic netting, requires no curing period and upon application forms an intimate bond with the soil surface to create a continuous, porous, absorbent and flexible erosion resistant blanket that allows for rapid germination and accelerated plant growth.

B. Related Sections: Other Specification Sections, which directly relate to the work of this Section include, but are not limited to the following:

1. *Section 01 57 00 – Temporary Erosion and Sediment Control*
2. *Section 02 24 23 – Chemical Sampling and Analysis of Soils*
3. *Section 31 00 00 – Earthwork*
4. *Section 31 91 00 – Planting Preparation*
5. *Section 32 01 90.16 – Amending Soils*
6. *Section 32 92 00 – Turf and Grasses*

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions. Include required substrate preparation, list of materials and application rate.

B. Certifications: Manufacturer shall submit a letter of certification that the product meets or exceeds all technical and packaging requirements and is made in the U.S.A.

1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in UV and weather-resistant factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage, weather, excessive temperatures and construction operations.

PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. PROFILE Products LLC
750 Lake Cook Road – Suite 440
Buffalo Grove, IL 60089
International - +1-847-215-1144
United States and Canada – 800-366-1180 (Fax 847-215-0577)
www.profileproducts.com

2.02 MATERIALS

A. The HP-FGM shall be Flexterra HP-FGM and conform to the following typical property values when uniformly applied at a rate of 3,500 pounds per acre (3,900 kilograms/hectare) under laboratory conditions.

Property	Test Method	Tested Value (English)	Tested Value (SI)
Physical			
Mass Per Unit Area	ASTM D6566[1]	≥ 11.6 oz/yd^2	≥ 390 g/m^2
Thickness	ASTM D6525[1]	≥ 0.22 inch	≥ 5.6 mm
Ground Cover	ASTM D6567[1]	≥ 99%	≥ 99%
Water Holding Capacity	ASTM D7367	≥ 1,700%	≥ 1,700%
Material Color	Observed	Green	Green
Performance			
Cover Factor[2]	Large Scale Testing[4]	≤ 0.01	≤ 0.01
% Effectiveness[3]	Large Scale Testing[4]	≥ 99%	≥ 99%
Cure time	Observed	0 - 2 hours	0 - 2 hours
Vegetation Establishment	ASTM D7322[1]	≥ 800%	≥ 800%
Functional Longevity[5]	ASTM D5338	≤ 18 months	≤ 18 months
Environmental			
Ecotoxicity	EPA 2021.0	48-hr LC_{50} > 100%	48-hr LC_{50} > 100%
Effluent Turbidity	Large Scale Testing[4]	≤ 250 NTU	≤ 250 NTU
Biodegradability	ASTM D5338	Yes	Yes

1. ASTM test methods developed for Rolled Erosion Control Products and have been modified to accommodate Hydraulically-Applied Erosion Control Products.
2. Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface.
3. % Effectiveness = One minus Cover Factor multiplied by 100%.
4. Large scale testing conducted at Utah Water Research Laboratory. For specific testing information please contact a Profile technical service representative at 800-508-8681 (US and Canada) or +1-847-215-1144 (International).
5. Functional Longevity is the estimated time period, based upon ASTM D5338 testing and field observations, that a material can be anticipated to provide erosion control and agronomic benefits as influenced by composition, as well as site-specific conditions, including; but not limited to – temperature, moisture, light conditions, soils, biological activity, vegetative establishment and other environmental factors.

2.03 COMPOSITION

A. All components of the HP-FGM shall be pre-packaged by the Manufacturer to assure both material performance and compliance with the following values. Under no circumstances shall field mixing of components be permitted. No chemical additives with the exception of fertilizer, soil neutralizers and biostimulant materials should be added to this product.

1. Thermally Processed* (within a pressurized vessel) Virgin Wood Fibers – 80%
   *Heated to a temperature greater than 380 degrees Fahrenheit (193 degrees Celsius) for 5 minutes at a pressure greater than 50 psi (345 kPa)
2. Wetting agents (including high-viscosity colloidal polysaccharides, cross-linked biopolymers, and water absorbents) – 10%
3. Crimped Biodegradable Interlocking Fibers – 5%
4. Micro-Pore Granules – 5%

2.04 PACKAGING

A. Bags: Net Weight – 50 lb (22.7 kg), UV and weather-resistant plastic film
Pallets: Weather-proof, stretch-wrapped with UV resistant pallet cover
Pallet Quantity: 40 bags/pallet or 1 ton (909 kg)/pallet

EXECUTION

3.01 SOIL TESTING

A. Soil Samples shall be taken and sent to a third-party, independent lab for analysis and in compliance with Section 02 24 23 – Chemical Sampling and Analysis of Soils, if applicable.

B. The tests shall include analysis and interpretation of results.

C. The soil testing methods used shall be compliant with recognized agronomic testing standards, as outlined in Section 02 24 23, for revegetation of disturbed sites.

D. Soil Analysis shall include results for:

1. Soil pH
2. Soluble Salts
3. Excess Carbonate
4. Organic Matter
5. Nutrient readings for:
    i. Nitrogen, Phosphorus, Potassium
    ii. Magnesium, Calcium, Sodium, Manganese, Sulfur, Zinc, Copper, Iron, Boron
6. Cation Exchange Capacity
7. Percent Base Saturation Sodium

E. ProGanics® BSM, BioPrime™, JumpStart™, Aqua-pHix™ and NeutraLime™ Dry or other amendments shall be specified according to Section 32 01 90.16 – Amending Soils and applied with the hydroseeding slurry at Manufacturer recommended rates based on soil test results.

3.02 VEGETATION SPECIES SELECTION

A. Once soils have been analyzed for agronomic potential and amendment recommendations, selection of suitable plant species for achieving sustainable growth and effective erosion control shall be determined by a qualified seed supplier, consulting professional and/or regulatory agency. Species selection and establishment shall be compliant with Section 32 92 00 – Turf and Grasses, if applicable.

B. Site and project specific information considered for species selection shall include:

1. Project Location and Planning
    i. Climate
    ii. Elevation
    iii. Aspect
    iv. Slope/Gradient
    v. Permanent or Temporary Planting
    vi. Installation Date(s)
2. Soil Conditions
    i. Soil Texture
    ii. Soil pH
    iii. Toxicities/Deficiencies noted in the previous section.
3. Site Maintenance Requirements
    i. Mowing
    ii. Irrigation
    iii. Animal grazing preference
4. Preferred Vegetation
    i. Drought Tolerant
    ii. Native Vegetation
    iii. Shrub Species
    iv. Turf Grasses

v. Cool Season
vi. Warm Season
vii. Blend of Cool and Warm Season
viii. Legume Species
ix. Cover Crops

3.03 SUBSTRATE AND SEEDBED PREPARATION

A. Examine substrates and conditions where materials will be applied. Apply products to geotechnically stable slopes that have been designed and constructed to divert runoff away from the face of the slope. Do not proceed with installation until satisfactory conditions are established.

B. Depending upon project sequencing and intended application, prepare seedbed in compliance with other specifications under Section 1.01 B

3.04 INSTALLATION

A. Strictly comply with equipment manufacturer's installation instructions and recommendations. Use approved hydroseeding machines with fan-type nozzle (50-degree tip). To achieve optimum soil surface coverage, apply HP-FGM from opposing directions to soil surface. Rough surfaces (rocky terrain, cat tracked and ripped soils) may require higher application rates to achieve 100% cover. Slope interruption devices or water diversion techniques are recommended when slope lengths (3H:1V) exceed 100 feet (30 m). Slope interruption intervals may need to be decreased based on steeper slopes or other site conditions. HP-FGM is not recommended for channels or areas with concentrated water flow unless used in conjunction with a rolled erosion control product designed to accommodate the anticipated hydraulic conditions. Unless approved by the Manufacturer, no chemical additives with the exception of fertilizer, soil neutralizers and biostimulant materials should be added to this product.

B. For Erosion Control and Revegetation: To ensure proper application rates, measure and stake area. For maximum performance, apply HP-FGM in a two-step process*:

1. *Step One: Apply fertilizer with specified prescriptive agronomic formulations and typically 50% of specified seed mix with a small amount of HP-FGM for visual metering. Do not leave seeded surfaces unprotected, especially if precipitation is imminent.*
2. *Step Two: Mix balance of seed and apply HP-FGM at a rate of 50 lb per 125 gallons (22.7 kg/475 liters) of water over freshly seeded surfaces. Confirm loading rates with equipment manufacturer.*

**Depending upon site conditions HP-FGM may be applied in a one-step process where all components may be mixed together in single tank loads. Consult with Manufacturer for further details.*

Best results and more rapid curing are achieved at temperatures exceeding 60°F (15°C). Curing times may be accelerated in high temperature, low humidity conditions with product applied on dry soils.

C. Mixing: A mechanically agitated hydroseeding machine is strongly recommended:

1. *Fill 1/3 of mechanically agitated hydroseeder with water. Turn pump on for 15 seconds and purge and pre-wet lines. Turn pump off.*
2. *Turn agitator on and load low density materials first (i.e. seed).*
3. *Continue slowly filling tank with water while loading fiber matrix into tank.*
4. *Consult application and loading charts to determine number of bags to be added for desired area and application rate. Mix at a rate of 50 lb of HP-FGM per 125 gallons (22.7 kg/475 liters).*
5. *All HP-FGM should be completely loaded before water level reaches 75% of the top of tank.*
6. *Top off with water and mix until all fiber is fully broken apart and hydrated (minimum of 10 minutes — increase mixing time when applying in cold conditions). This is very important to fully activate the bonding additives and to obtain proper viscosity.*
7. *Add fertilizer and any other remaining amendments.*
8. *Shut off recirculation valve to minimize potential for air entrainment within the slurry.*
9. *Slow down agitator and start applying with a 50-degree fan tip nozzle.*
10. *Spray in opposing directions for maximum soil coverage.*

D. Application Rates: These application rates are for standard conditions. Application rates may need to be increased to accommodate very rough surfaces.

Slope Gradient / Condition	**English**	**SI**
≤ 4H to 1V	2,500 lb/ac	2,800 kg/ha
> 4H to 1V and ≤ 3H to 1V	3,000 lb/ac	3,400 kg/ha
> 3H to 1V and ≤ 2H to 1V	3,500 lb/ac	3,900 kg/h
> 2H to 1V and ≤ 1H to 1V	4,000 lb/ac	4,500 kg/ha
> 1H to 1V	4,500 lb/ac	5,100 kg/ha
Below ECB or TRM	1,500 lb/ac	1,700 kg/ha
As infill for TRM*	3,500 lb/ac	3,900 kg/ha

*Use only approved and tested Futerra® Turf Reinforcement Mats (TRMs) to create the GreenArmor™ System

For additional details including mixing ratios/loading rates for specific machine sizes and visual keys for proper application, please consult Profile® Application Guide for HP-FGM™ and ET-FGM™.

3.05 CLEANING AND PROTECTION

A. After application, thoroughly flush the tank, pumps and hoses to remove all material. Wash all material from the exterior of the machine and remove any slurry spills. Once dry, material will be more difficult to remove.

B. Clean spills promptly. Advise owner of methods for protection of treated areas. Do not allow treated areas to be trafficked or subjected to grazing.

3.06 INSPECTION AND MAINTENANCE

A. All inspections and maintenance recommendations shall be conducted by qualified professionals consistent with the owner, engineer/specifier and regulatory entity(ies) expectations.

B. Initial inspections shall insure installations are in accordance with the project plans and specifications with material quantities and activities fully documented. Refer to Section 32 92 00 – Turf and Grasses for any additional details.

C. Subsequent inspections shall be conducted at pre-determined time intervals and corrective maintenance activities directed after each significant precipitation or other potentially damaging weather or site event.

Revision Date: 03/2017

1 PRODUCT AND COMPANY IDENTIFICATION

Manufacturer

PROFILE Products, LLC
750 LAKE COOK ROAD
SUITE 440
BUFFALO GROVE, IL 60089

Emergency:	Emergency Phone: (800) 424-9300 (ChemTrec
Contact:	ChemTrec Acct #: CCN792719
Phone:	(847) 215-1144
Fax:	(847) 215-0577
Email:	tech@profileproducts.com
Web:	www.profileproducts.com

Product Name:	Flexterra® High Performance-Flexible Growth Medium™(HP-FGM™)
Revision Date:	1/1/17
SDS Number:	CON062
CAS Number:	Not applicable
Product Use:	Erosion control and revegetation mulch for hydraulic seeding.

Product Description: Green dyed wood fibers, biodegradable fibers, minerals and a proprietary binder mixture.

2 HAZARDS IDENTIFICATION

Classification of the Substance or Mixture

GHS Classification in Accordance with 29 CFR 1910 (OSHA HCS):

No GHS Classifications Indicated

GHS Label Elements, Including Precautionary Statements

GHS Signal Word: NONE

no GHS pictograms indicated for this product

GHS Hazard Statements:

no GHS hazards statements indicated

GHS Precautionary Statements:

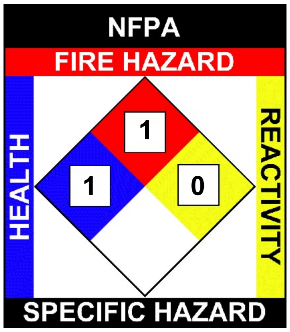
no GHS precautionary statements indicated

Hazards not Otherwise Classified (HNOC) or not Covered by GHS

Route of Entry:	Inhalation, skin contact, eye contact
Inhalation:	Wood may cause sneezing, irritation, and dryness of the nose and throat. Dust may aggravate pre-existing respiratory conditions.
Skin Contact:	Wood dust can cause irritation. Skin absorption is not known to occur.
Eye Contact:	Wood dust can irritate the eyes.
Ingestion:	No reports of human ingestion.

OSHA Classification: Wood dust is a hazardous substance as defined by the Hazard Communication Standard 29CFR 1910.1200

NFPA: Health = 1, Fire = 1, Reactivity = 0, Specific Hazard = n/a



3 COMPOSITION/INFORMATION OF INGREDIENTS

Ingredients:

Cas#	%	Chemical Name
0	Proprietary	Hydrocolloidal Based Polysaccharide Tackifier
9000300	Proprietary	Guar Gum

4 FIRST AID MEASURES

Inhalation: Usually not a problem. Remove to fresh air if respiratory irritation develops, and get medical aid promptly if irritation persists. In high dust levels wear dust mask.

Skin Contact: Usually not a problem. Wash off with running water if irritation is experienced.

Eye Contact: Open eyelids and flush with water.

Ingestion: Get medical attention.

5 FIRE FIGHTING MEASURES

Flammability: Combustible product

Flash Point: Not applicable

Flash Point Method: Not applicable

Autoignition Temp: 200-260°C (400-500°F)

Conditions to avoid: In contact with flames or hot surfaces.

Flammable- Extinguish with water; same as a wood fire

6 ACCIDENTAL RELEASE MEASURES

Scoop up product. Wear goggles and respirator if dust is produced in unventilated areas. Wet product will be slippery.

7 HANDLING AND STORAGE

Handling Precautions: Clean up areas where dust settles. Minimize blowdown or other practices that generate high airborne dust concentrations.

Storage Requirements: Store in a cool, dry place. Keep away from sources of ignition.

8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls: None required for outdoor mixing and application. Use dust collection system for indoor handling operations.

Personal Protective Equipment: Eye Protection: Wear goggles when emptying bags and during other operations where there is a risk of dust entering the eyes.
Gloves: Leather, plastic or rubber gloves could be worn to minimize skin irritation.
Respirators: When handling methods generate dust at concentrations that exceed occupational exposure limits, wear a NIOSH approved respirator. A fabric respirator or a facepiece respirator with dust cartridges will generally provide adequate protection.
Footwear: The product is slippery when wet. Wear appropriate footwear.

9 PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Dyed green wood fibers - Pine & mixed hardwoods
Physical State: Wood Fibers **Odor:** Mild wood odor
Spec Grav./Density: Lighter than water
Vapor Pressure: N/A

10 STABILITY AND REACTIVITY

Chemical Stability: Stable product.
Conditions to Avoid: Contact with strong acids and oxidizers may generate heat. Product may ignite at temperatures in excess of 200°C (400°F).
Materials to Avoid: Strong acids and oxidizers.
Hazardous Polymerization: Will not occur.

11 TOXICOLOGICAL INFORMATION

EFFECTS OF CHRONIC EXPOSURE:

Inhalation: Frequent and repeated exposure to wood dust is associated with an increased risk of developing nasal cancer.
Skin Contact: Although rare, wood dust may cause dermatitis in sensitized people.

Occupational Exposure Limits:

Wood dusts- All other species: ACGIH (2007): TLV-TWA 1 mg/m³ (Inhalable fraction); A4

Particulates Not Otherwise Regulated (PNOR): OSHA: PEL-TWA 15 mg/m³ (Total Dust); 5 mg/m³ (Respirable fraction)

Irritancy: Wood dust is a mild irritant
Sensitization: Some wood dusts may cause allergic skin reactions

12 ECOLOGICAL INFORMATION

Guar Gum (CAS# 9000-30-0) is listed as an inert ingredient permitted for use in nonfood use pesticide products by EPA. It is also classified under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) as a minimal risk inert substance (List 4A) meaning that as a pesticide, Guar Gum is considered by the EPA to pose little or no risk to humans or the environment. The US Department of Agriculture (USDA) National Organic Program (NOP) also allows the use of Guar Gum in a variety of applications, but primarily as a pesticide in organic production operations. Finally, Guar Gum is listed on the Generally Recognized as Safe (GRAS) list by the Food and Drug Administration (FDA).

48-hr LC_{50} = >100% for Daphnia magna when runoff generated using ASTM D7101 (2"/hr rainfall rate) was tested according to EPA-821-R-02-012.

13 DISPOSAL CONSIDERATIONS

Normally can be disposed of as a wood residue. Ensure disposal is in compliance with local, provincial (state), and federal regulations.

14 TRANSPORT INFORMATION

15 REGULATORY INFORMATION

Component (CAS#) [%] - CODES

Hydrocolloidal Based Polysaccharide Tackifier (0) [Proprietary]

Guar Gum (9000300) [Proprietary] TSCA

Regulatory CODE Descriptions

TSCA = Toxic Substances Control Act

COMPONENT / (CAS/PERC) / CODES

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*Guar gum (9000300 n/a%) TSCA

REGULATORY KEY DESCRIPTIONS

MASS = MA Massachusetts Hazardous Substances List

NRC = Nationally Recognized Carcinogens

OSHAWAC = OSHA Workplace Air Contaminants

PA = PA Right-To-Know List of Hazardous Substances

TXAIR = TX Air Contaminants with Health Effects Screening Level

CERCLA = Superfund clean up substance

CSWHS = Clean Water Act Hazardous substances

EHS302 = Extremely Hazardous Substance

EPCRAWPC = EPCRA Water Priority Chemicals

HAP = Hazardous Air Pollutants

NJEHS = NJ Extraordinarily Hazardous Substances

NJHS = NJ Right-to-Know Hazardous Substances

OSHAPSM = OSHA Chemicals Requiring process safety management

SARA313 = SARA 313 Title III Toxic Chemicals

TSCA = Toxic Substances Control Act

16 OTHER INFORMATION

Disclaimer:
Although reasonable care has been taken in the preparation of this document, we extend no warranties and make no representations as to the accuracy or completeness of the information contained herein, and assume no responsibility regarding the suitability of this information for the user's intended purposes or for the consequences of its use. Each individual should make a determination as to the suitability of the information for their particular purpose(s).

TC Energy

Attachment D

Switchgrass Erosion Control Products

Quality Tested

Extensive testing of our switch erosion control product by Zane State College Students.

The Enhancements of Switch grass

- Switch grass is lighter than wood chips and other products now being used in filter sock making it more ergonomic and less strenuous for laborers to install.
- Switch grass is lighter to haul and transport than other products.
- Switch grass is a neutral product having little to no heavy metal in its makeup; other products used such as wood chips hold toxins that leach into the soil. Wood Chips with toxic (heavy) metals, such as lead, arsenic, or cadmium, is a serious concern because once these elements enter the soil they can persist for a long time. Livestock, especially horses, that drink the runoff from some types of wood chips in filter socks that pool water at times may cause said livestock to colic and die.

The Right Product For The Job
The One Nature Intended

BEG Group LLC. Patent Pending Product

Get The Big Switch

Bio-Run-Mat (BRM)

Erosion Control

Erosion Facts

While erosion is a natural process, human activities have increased by 10-40 times the rate at which erosion is occurring globally. Excessive (or accelerated) erosion causes both 'on-site' and 'off-site' problems. On-site impacts include decreases in agricultural productivity and (on natural landscapes) ecological collapse, both because of loss of the nutrient-rich upper soil layers. In some cases, the eventual end result is desertification. Off-site effects include sedimentation of waterways and eutrophication of water bodies, as well as sediment-related damage to roads and houses. Water and wind erosion are the two primary causes of land degradation; combined, they are responsible for about 84% of the global extent of degraded land, making excessive erosion one of the most significant environmental problems world-wide.

Product Information

8" Switchgrass	200 ft./ pallet
12" Switchgrass	135 ft./ pallet
18" Switchgrass	50 ft./ pallet
24" Switchgrass	Field install
32" Switchgrass	Field install
36" Switchgrass	Field install

BEG Group LLC

Switchgrass
Biodegradable Runoff Media Filter
Specifications

Switchgrass Erosion Control Product Properties

PHYSICAL PROPERTIES					
Pre-manufactured or Blown In on site	9"	12"	18"	24"	32"
Density lb./ft.3	5.70	5.12	4.86	4.34	3.85
Functional Longevity (months)	18	18	18	18	18
University Laboratory Tested	Yes	Yes	Yes	Yes	Yes
Manufactured Ready To Use	Yes	Yes	No	No	No
Seamless Construction	Yes	Yes	Yes	Yes	Yes

Laboratory Testing conducted by ZaneState College Cambridge, Ohio Campus
In accordance with the Texas A&M study

Netting available
- Photodegradable
- Biodegradable
- Cotton

Media Content
- 100% Switchgrass

Anchor
- 1.5" wood Stakes to be installed max 7' on center
- 2"to 3" trenching recommended as slope increases

Test Results Average % Removal	
TSS	67.5 %
Phosphate	57.2 %
Nitrite	21.1 %
Nitrate	18.4 %
Turbidity	74.9 %
Tannic acid	50.0 %

Switchgrass Erosion Control Products meet the following Requirements:

1. Switchgrass has been tested and proven to reduce turbidity, reduce nitrate levels and has shown to reduce, and does not contribute to, tannic acids levels.

2. The Switchgrass biodegradable runoff filter serves as a silt filter and a pollution neutralizing barrier which can be installed along the perimeter of an area that is known to produce polluted surface runoff. The biodegradable filter sock is made from a biodegradable mesh that is water permeable and is photodegradable. This allows the user to leave the product in a specific location to filter runoff and eventually decay into environment friendly materials.

3. Switchgrass typically allows for a greater water flow through when compared to a similar mass of woodchips. Thus, greater volumes of water is capable of flowing through the switchgrass while being filtered. This is useful as increased flow helps prevent the possibility of water pooling on one side of the filter sock and potentially causing ground erosion or spilling over the top of the filter sock.

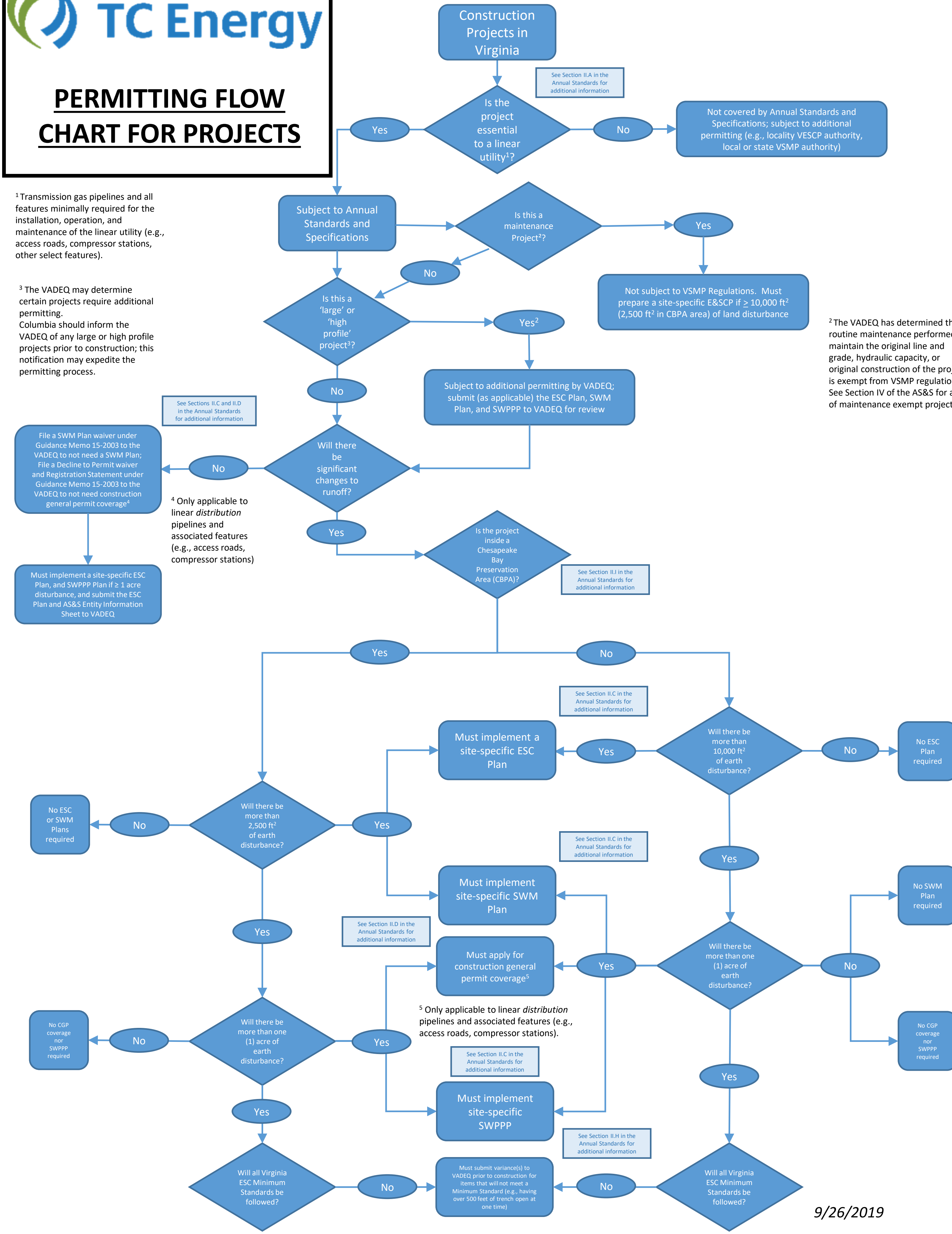
APPENDIX B:
PERMITTING FLOWCHART

VIRGINIA PROJECTS

September 2019

TC Energy

PERMITTING FLOW CHART FOR PROJECTS



[1] Transmission gas pipelines and all features minimally required for the installation, operation, and maintenance of the linear utility (e.g., access roads, compressor stations, other select features).

[2] The VADEQ has determined that routine maintenance performed to maintain the original line and grade, hydraulic capacity, or original construction of the project is exempt from VSMP regulations. See Section IV of the AS&S for a list of maintenance exempt projects.

[3] The VADEQ may determine certain projects require additional permitting.
Columbia should inform the VADEQ of any large or high profile projects prior to construction; this notification may expedite the permitting process.

[4] Only applicable to linear *distribution* pipelines and associated features (e.g., access roads, compressor stations)

[5] Only applicable to linear *distribution* pipelines and associated features (e.g., access roads, compressor stations).

9/26/2019

APPENDIX C:
GUIDANCE MEMO 15-2003

VIRGINIA PROJECTS

September 2019

TC Energy

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER DIVISION

Subject: **Guidance Memo No. 15-2003**
Postdevelopment Stormwater Management Implementation Guidance for Linear Utility Projects under the Virginia Stormwater Management Program Regulation, 9VAC25-870

To: Regional Directors and Local VSMP Administrators

From: Melanie D. Davenport, Director Melanie D Davenport

Date: April 23, 2015

Copies: James Golden, Jeff Steers, Fred Cunningham, Joan Salvati, Allan Brockenbrough, Jerome Brooks, Regional Stormwater Compliance Managers

Summary:

Section 76 (Linear Development Projects) of the Virginia Stormwater Management Program (VSMP) Regulation, 9VAC25-870, sets forth the postdevelopment stormwater management requirements for linear development projects. The purpose of this guidance document is to clarify the implementation of Section 76 with regards to the construction of linear utilities (e.g., waterlines, sewer lines, electric lines, telephone lines, oil and gas distribution pipelines, etc.) and was developed for use by the Department and local VSMP Authorities.

Electronic Copy:

An electronic copy of this guidance document in PDF format is available for staff internally on DEQNET, and for the general public on DEQ's website at: http://www.deq.virginia.gov/Programs/Water/Laws,Regulations,Guidance/Guidance/WaterPermitGuidance.aspx.

Contact Information:

Please contact Drew Hammond, Office of Stormwater Management, at (804) 698-4037 or Andrew.Hammond@deq.virginia.gov with any questions regarding the application of this guidance.

Disclaimer:

This document is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, it does not mandate or prohibit any particular action not otherwise required or prohibited by law or regulation. If alternative proposals are made, such proposals will be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.

Postdevelopment Stormwater Management Implementation Guidance for Linear Utility Projects under the Virginia Stormwater Management Program Regulation, 9VAC25-870

Definitions:

"Land disturbance" or "land-disturbing activity" means a manmade change to the land surface that potentially changes its runoff characteristics including clearing, grading, or excavation, except that the term shall not include those exemptions specified in § 62.1-44.15:34 of the Code of Virginia.

"Linear development project" means a land-disturbing activity that is linear in nature such as, but not limited to, (i) the construction of electric and telephone utility lines, and natural gas pipelines; (ii) construction of tracks, rights-of-way, bridges, communication facilities and other related structures of a railroad company; (iii) highway construction projects; (iv) construction of stormwater channels and stream restoration activities; and (v) water and sewer lines. Private subdivision roads or streets shall not be considered linear development projects.

"Postdevelopment" refers to conditions that reasonably may be expected or anticipated to exist after completion of the land development activity on a specific site.

"Predevelopment" refers to the conditions that exist at the time that plans for the land development of a tract of land are submitted to the VSMP authority. Where phased development or plan approval occurs (preliminary grading, demolition of existing structures, roads and utilities, etc.), the existing conditions at the time prior to the first item being submitted shall establish predevelopment conditions.

“Stabilized” means land that has been treated to withstand normal exposure to natural forces without incurring erosion damage.

"Stormwater management plan" means a document(s) containing material for describing methods for complying with the requirements of the VSMP Regulation, 9VAC25-870.

“Virginia Stormwater Management Program (VSMP) authority” means an authority approved by the Board after September 13, 2011 to operate a Virginia Stormwater Management Program or the Department.

Regulatory Text:

9VAC25-870-76. Linear development projects.

Linear development projects shall control postdevelopment stormwater runoff in accordance with a site-specific stormwater management plan or a comprehensive watershed stormwater management plan developed in accordance with these regulations.

Guidance:

Section 76 of the VSMP Regulation, 9VAC25-870, establishes the requirement that linear development projects control postdevelopment stormwater runoff in accordance with a site-specific stormwater management plan or a comprehensive watershed stormwater management plan. The purpose of this guidance document is to clarify the implementation of Section 76 with regard to the construction of linear utilities (e.g., waterlines, sewer lines, electric lines, telephone lines, oil and gas distribution pipelines, etc.) and was developed for use by the Department and local VSMP Authorities.

The VSMP Regulation does not distinguish between various types of linear development projects such as aboveground or underground utilities, highway construction, rights-of-way, bridges, tracks and related structures of a railroad company. The Department of Environmental Quality (DEQ) recognizes that the construction of aboveground or underground linear utilities may not result in changes to the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization. Also, the application of the postdevelopment water quantity and water quality controls to these types of projects and the preparation and implementation of a stormwater management plan may provide minimum water quality benefit. Examples of such projects include:

- The installation of underground utilities (e.g., waterlines, sewer lines, oil and gas distribution pipelines) beneath existing impervious cover (e.g., asphalt pavement, concrete pavement) that will be returned to its predevelopment condition after the completion of construction and final stabilization;

- The installation of underground utilities (e.g., waterlines, sewer lines, oil and gas distribution pipelines) beneath existing pervious cover (e.g., forest/open space, managed turf) that will be returned to its predevelopment condition after the completion of construction and final stabilization; or

- The installation of aboveground (i.e., overhead) utility lines.

DEQ staff or the local VSMP authority should utilize their best professional judgment when evaluating aboveground or underground linear utility projects. If the project will not result in significant changes to the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization, then DEQ or the local VSMP authority, at their discretion, may waive the requirement for the preparation and implementation of a stormwater management plan. DEQ recognizes that on a site specific basis a stormwater management plan may be required especially if the linear utility project will significantly alter the predevelopment runoff characteristics of the land surface.

In addition, the construction of aboveground or underground linear utilities may be conducted without requiring coverage under the General VPDES Permit for Discharges of Stormwater from Construction Activities (Construction General Permit) provided that:

- The project does not significantly alter the predevelopment runoff characteristics of the land surface after the completion of construction and final stabilization;

- The project is managed so that less than one (1) acre of land disturbance occurs on a daily basis;

- The disturbed land where work has been completed is adequately stabilized on a daily basis;

- The environment is protected from erosion and sedimentation damage associated with the land-disturbing activity;

- The owner and/or construction activity operator designs, installs, implements, and maintains pollution prevention measures to:

  - Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters;

  - Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, and other materials present on-site to precipitation and to stormwater;

  - Minimize the discharge of pollutants from spills and leaks and implement chemical spill and leak prevention and response procedures;

  - Prohibit the discharge of wastewater from the washout of concrete;

  - Prohibit the discharge of wastewater from the washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials; and

  - Prohibit the discharge of fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance.

- The owner and/or construction activity operator provides reasonable assurance to DEQ or the local VSMP Authority that all of the above conditions will be satisfied. This may be accomplished by incorporating these conditions into an erosion and sediment control plan developed for the project.

As previously noted, DEQ staff or the local VSMP authority should utilize their best professional judgment when evaluating aboveground or underground linear utility projects. If the owner and/or construction activity operator provides reasonable assurance to DEQ or the local VSMP Authority that all of the aforementioned conditions will be satisfied, then the linear utility project may be conducted without requiring coverage under the Construction General Permit. Please note that this does not relieve the owner and/or construction activity operator from complying with any and all other applicable federal, state, and local requirements. DEQ or the local VSMP Authority reserves the right to require a registration statement for Construction General Permit coverage if the aforementioned conditions are not satisfied.

If the linear utility project will significantly alter the predevelopment runoff characteristics of the land surface requiring postdevelopment stormwater management or if other site specific conditions warrant Construction General Permit coverage, DEQ or the local VSMP authority may require a registration statement for permit coverage.

APPENDIX D:
PLAN SUBMITTER'S CHECKLIST FOR EROSION AND SEDIMENT CONTROL PLANS

VIRGINIA PROJECTS

September 2019

TC Energy

PLAN SUBMITTER'S CHECKLIST

FOR EROSION AND SEDIMENT CONTROL PLANS

Please fill in all blanks and reference the plan sheets/pages where the information may be found, where appropriate, or write N/A by items that are not applicable.

GENERAL

Plan Submission Date ____
Project Name ____
VSMP Permit Number ____
Site Plan Number ____
Site Address ____
Applicant ______________________________ Phone Number ____________
Applicant Legal Address ____
Owner ______________________________ Phone Number ____________
Principal Designer ______________________________ Phone Number ____________
General Contractor ______________________________ Phone Number ____________

______ Complete set of plans- Include all sheets pertaining to the site grading and stormwater and any activities impacting erosion and sediment control and drainage:

- ☐ Existing conditions
- ☐ Demolition
- ☐ Site grading
- ☐ Erosion and sediment control
- ☐ Storm sewer systems
- ☐ Stormwater management facilities
- ☐ Utility layout
- ☐ Landscaping
- ☐ On-site and off-site borrow and disposal areas that do not have separate approved ESC Plans

______ Professional's seal - The designer's original seal, signature, and date are required on the *cover* sheet of each Narrative and each set of Plan Sheets. A facsimile is acceptable for subsequent Plan Sheets.

______ Number of plan sets - Two sets of ESC Plans should be submitted. The DEQ office will retain all submitted plans.

______ Variances - Variances requested at the time of plan submission are governed by Section 9VAC25-840-50 of the *Virginia Erosion and Sediment Control Regulations*.

______ Certified Responsible Land Disturber (RLD) - A certified RLD is required during all stages of construction, from the initial land disturbance through final site stabilization**. The name of the project RLD must be provided before any land disturbance may begin.** Notify DEQ in a timely manner if the RLD changes during the course of the project.

______ Local Consideration – Plans have been provided to the applicable jurisdictions.

- ☐ Dulles Airport (MWAA)
- ☐ Fairfax County
- ☐ Loudoun County
- ☐ Town of Herndon
- ☐ Dulles Greenway (Trip II)
- ☐ VDOT

CHECKLIST PREPARER

I certify that I am a professional in adherence to all minimum standards and requirements pertaining to the practice of that profession in accordance with Chapter 4 (§ 54.1-400 et seq.) of Title 54.1 of the Code of Virginia and attendant regulations. By signing this checklist I am certifying that this document and all attachments are, to the best of my knowledge and belief, true, accurate, and complete.

SIGNATURE ____

PRINTED NAME ____

QUALIFICATIONS ______________________________________

DATE ____

NARRATIVE
Please reference plan sheet numbers where the information may be found.

______ Project description - Briefly describe the nature and purpose of the land-disturbing activity. Provide the area (acres) to be disturbed.

______ Existing site conditions - A description of the existing topography (% slopes), ground cover, and drainage (on-site and receiving channels).

______ Adjacent areas - A description of all neighboring areas such as residential developments, agricultural areas, streams, lakes, roads, etc., that might be affected by the land disturbance.

______ Off-site areas - Describe any off-site land-disturbing activities that may occur (borrow sites, disposal areas, easements, etc.). Identify the Owner of the off-site area and the entity responsible for plan review. Include a statement that any off-site land-disturbing activity associated with the project must have an approved ESC Plan. Submit documentation of the approved ESC Plan for each of these sites.

_____ Soils - Provide a description of the soils on the site, giving such information as soil name, mapping unit, erodibility, permeability, surface runoff, and a *brief* description of depth, texture and soil structure. Show the site location on the Soil Survey, if it is available. Include a plan showing the boundaries of each soil type on the development site.

______ Critical areas - A description of areas on the site that have potentially serious erosion problems or that are sensitive to sediment impacts (e.g., steep slopes, watercourses, wet weather / underground springs, etc.).

______ Erosion and sediment control measures - A description of the structural and vegetative methods that will be used to control erosion and sedimentation on the site. Controls should satisfy applicable minimum standards and specifications in Chapter 3 of the 1992 *Virginia Erosion and Sediment Control Handbook* (VESCH) or more stringent local requirements.

______ Management strategies / Sequence of construction - Address management strategies, the sequence of construction, and any phasing of installation of ESC measures.

______ Permanent stabilization - A brief description, including specifications, of how the site will be stabilized after construction is completed.

______ Maintenance of ESC measures - A schedule of regular inspections, maintenance, and repair of erosion and sediment control structures should be set forth.

______ Calculations for temporary erosion and sediment control measures - For each temporary ESC measure, provide the calculations required by the standards and specifications.

______ Stormwater management considerations - Will the development of the site cause an increase in peak runoff rates? Will the increase in runoff cause flooding or channel degradation downstream? Describe the strategy to control stormwater runoff, including during construction.

PROJECT NAME: ____ SUBMITTAL#: _________

PLANS DATED: ____________

_______ Specifications / Detail Drawings for erosion and sediment control measures - For each erosion and sediment control measure employed in the plan, include, at a minimum, the detail from the standard and specification in the VESCH or more stringent local requirements. Include any approved variances or revisions to the standards and specifications.

_______ Specifications for stormwater and stormwater management structures - Provide specifications for stormwater and stormwater management structures, i.e., pipe materials, pipe bedding, stormwater structures.

PROJECT NAME: ____ SUBMITTAL#: _________

PLANS DATED: _____________

SITE PLAN
Please reference plan sheet numbers where the information may be found.

______ Vicinity map - A small map locating the site in relation to the surrounding area. Include any landmarks that might assist in locating the site.

______ Indicate north - The direction of north in relation to the site.

______ Off-site areas - Include any off-site land-disturbing activities (e.g., borrow sites, disposal areas, etc.) not covered by a separate approved ESC Plan.

______ Legend - Provide a complete listing of all ESC measures used, including the VESCH uniform code symbol and the standard and specification number. Include any other items necessary to identify pertinent features in the plan.

______ Property lines and easements - Show all property and easement lines. For each adjacent property, list the deed book and page number and the property owner's name and address.

______ Existing vegetation – Show the existing tree lines, grassed areas, or unique vegetation.

______ Limits of clearing and grading – Delineate all areas that are to be cleared and graded.

______ Protection of areas not being cleared - Fencing or other measures to protect areas that are not to be disturbed on the site.

______ Critical areas – Note all critical areas on the plan.

______ Existing contours – Show the existing contours of the site.

______ Final contours and elevations – Show changes to the existing contours, including final drainage patterns.

______ Site development – Show all improvements such as buildings, parking lots, access roads, utility construction, etc. Show all physical items that could affect or be affected by erosion, sediment, and drainage.

______ Location of practices - The locations of erosion and sediment control and stormwater management practices used on the site. Use the standard symbols and abbreviations in Chapter 3 of the VESCH.

______ Adequate Conveyances – Ensure that stormwater conveyances with adequate capacity and adequate erosion resistance have been for provided all on-site concentrated stormwater runoff. Off-site channels that receive runoff from the site, including those receiving runoff from stormwater management facilities, must be adequate. Increased volumes of sheet flows must be diverted to a stable outlet, adequate channel, pipe or pipe system, or a stormwater management facility.

PROJECT NAME: ____ SUBMITTAL#: _________

PLANS DATED: _____________

☐ Provide exhibits showing the drainage divides, the direction of flow, and the size (acreage) of each of the site drainage areas that discharge runoff off-site, both existing and proposed.
☐ Provide calculations for pre- and post-development runoff from these drainage areas.
☐ Ensure that Minimum Standard 19 is satisfied for each off-site receiving channel, including those that receive runoff from stormwater management facilities.
☐ Provide calculations for the design of each permanent stormwater management facility.
☐ Ensure that increased volumes of sheet flows are diverted to a stable outlet, to an adequate channel, pipe or pipe system, or to a stormwater management facility.
☐ Provide adequacy calculations for all on-site stormwater conveyances.

______ Calculations for permanent stormwater conveyances - For each permanent stormwater conveyance or structure, provide the following design calculations, as applicable:

☐ Drainage area map with time of concentration (T_C) path shown
☐ T_C calculation/nomograph
☐ Locality IDF curve
☐ Composite runoff coefficient or RCN calculation
☐ Peak runoff calculations
☐ Stormwater conveyance channel design calculations
☐ Storm drain and storm sewer system design calculations
☐ Hydraulic Grade Line if any pipe in the system is more than 90% full for a 10-year storm
☐ Culvert design calculations
☐ Drop inlet backwater calculations
☐ Curb inlet length calculations

______ Direction of Flow for Conveyances - Indicate the direction of flow for all stormwater conveyances (storm drains, stormwater conveyance channels).

______ Storm Drain Profiles - Provide profiles of all storm drains except roof drains. If the type of pipe (RCP, CMP, HDPE, etc.) is not called out on the profiles, then the most conservative pipe material that may be specified for the project must be used in the adequacy calculations.

PROJECT NAME: ____ SUBMITTAL#: _________

PLANS DATED: _____________

MINIMUM STANDARDS
Plan Sheet #

______ **Minimum Standards - All Minimum Standards must be addressed.**

Yes No NA

[] [] [] MS-1 Have temporary and permanent stabilization been addressed in the narrative?
[] [] [] Are practices shown on the plan?
[] [] [] Temporary and permanent seed specifications?
[] [] [] Lime and fertilizer?
[] [] [] Mulching?
[] [] [] Blankets/Matting?
[] [] [] Pavement/Construction Road Stabilization?

[] [] [] MS-2 Has stabilization of soil stockpiles, borrow areas, and disposal areas been addressed in the narrative and on the plan?
[] [] [] Have sediment trapping measures been provided?

[] [] [] MS-3 Has the establishment and maintenance of permanent vegetative stabilization been addressed?

[] [] [] MS-4 Does the plan specifically state that sediment-trapping facilities shall be constructed as a first step in land-disturbing activities?

[] [] [] MS-5 Does the plan specifically state that stabilization of earthen structures is required immediately after installation? Is this noted for each measure on the plan?

[] [] [] MS-6 Are sediment traps and sediment basins specified where needed and designed to the standard and specification?

[] [] [] MS-7 Have the design and temporary/permanent stabilization of cut and fill slopes been adequately addressed? Is Surface Roughening provided for slopes steeper than 3:1?

[] [] [] MS-8 Have adequate temporary or permanent conveyances (paved flumes, channels, slope drains) been provided for concentrated stormwater runoff on cut and fill slopes?

[] [] [] MS-9 Has water seeping from a slope face been addressed (e.g., subsurface drains)?

[] [] [] MS-10 Is adequate inlet protection provided for all operational storm drain and culvert inlets?

PROJECT NAME: ____ SUBMITTAL#: _________

PLANS DATED: _____________

Yes No NA

[] [] [] MS-11 Are adequate outlet protection and/or channel linings provided for all stormwater conveyance channels and receiving channels? Is there a schedule indicating:
[] [] [] Dimensions of the outlet protection? Lining? Size of riprap?
[] [] [] Cross section and slope of the channels? Type of lining? Size of riprap, if used?

[] [] [] MS-12 Are in-stream protection measures required so that channel impacts are minimized?

[] [] [] MS-13 Are temporary stream crossings of non-erodible material required where applicable?

[] [] [] MS-14 Are all applicable federal, state and local regulations pertaining to working in or crossing live watercourses being followed?

[] [] [] MS-15 Has immediate restabilization of areas subject to in-stream construction (bed and banks) been adequately addressed?

[] [] [] MS-16 Have disturbances from underground utility line installations been addressed?
[] [] [] No more than 500 linear feet of trench open at one time?
[] [] [] Effluent from dewatering filtered or passed through a sediment-trapping device?
[] [] [] Proper backfill, compaction, and restabilization?

[] [] [] MS-17 Is the transport of soil and mud onto public roadways properly controlled? (i.e., Construction Entrances, wash racks, transport of sediment to a trapping facility, cleaning of roadways at the end of each day, no washing before sweeping and shoveling)

[] [] [] MS-18 Has the removal of temporary practices been addressed?
[] [] [] Have the removal of accumulated sediment and the final stabilization of the resulting disturbed areas been addressed?

[] [] [] MS-19 Are properties and waterways downstream from development adequately protected from sediment deposition, erosion, and damage due to increases in volume, velocity and peak flow rate of stormwater runoff? Have adequate channels been provided on-site?

PROJECT NAME: ____ SUBMITTAL#: _________

PLANS DATED: _____________

APPENDIX E:
PLAN SUBMITTER'S CHECKLIST FOR STORMWATER MANAGEMENT PLANS

VIRGINIA PROJECTS

September 2019

TC Energy

PLAN SUBMITTER'S CHECKLIST

FOR STORMWATER MANAGEMENT PLANS

Please fill in all blanks and **please reference the plan sheets/pages where the information may be found**, where appropriate, or write N/A by items that are not applicable.

GENERAL

Plan Submission Date ______________________________
Project Name ______________________________
VSMP Permit Number ______________________________
Site Plan Number ______________________________
Site Address ______________________________
Applicant ______________________________ Phone Number ______________
Applicant Legal Address ______________________________
Owner ______________________________ Phone Number ______________
Owner E-mail Address ______________________________
Principal Designer ______________________________ Phone Number ______________
Principal Designer E-mail Address ______________________________
Total Disturbed Area Figure ______________

______ Professional's seal - The designer's original seal, signature, and date are required on the *cover* sheet of each Narrative and each set of Plan Sheets. A facsimile is acceptable for subsequent Plan Sheets.

______ Number of plan sets – Attach two sets of SWM Plans.

______ Exceptions - Exceptions requested are governed by Section 9VAC25-870-57 of the *Virginia Stormwater Management Regulations*.

______ Local Consideration – Provide contact information for the locality's plan review coordinator.

Name ______________________________ Phone Number ______________
Address ______________________________

______ Grandfathering - Attach supporting documentation consistent with the requirements of Section 9VAC25-870-48 of the *Virginia Stormwater Management Regulations*.

______ Offsite Compliance – Attach letter of availability from the off-site provider as governed by Section 9VAC25-870-55 of the *Virginia Stormwater Management Regulations*.

PROJECT NAME: ______________________________ SUBMITTAL#: __________

PLANS DATED: ______________

CHECKLIST PREPARER

I certify that I am a professional in adherence to all minimum standards and requirements pertaining to the practice of that profession in accordance with Chapter 4 (§ 54.1-400 et seq.) of Title 54.1 of the Code of Virginia and attendant regulations. By signing this checklist I am certifying that this document and all attachments are, to the best of my knowledge and belief, true, accurate, and complete.

SIGNATURE ____

PRINTED NAME ____

QUALIFICATIONS ______________________________________

DATE ____

PROJECT NAME: _______________________________________ SUBMITTAL#: ________

PLANS DATED: ____________

SITE PLANS

Please reference the plan sheet numbers where specific information may be found in the blanks below.

______ Common address and legal description of the site, including the tax reference number(s) and parcel number(s) of the property or properties affected.

______ A narrative that includes a description of current site conditions and proposed development and final site conditions, including proposed use of environmental site design techniques and practices, stormwater control measures, relevant information pertaining to long-term maintenance of these measures, and a construction schedule.

______ Existing and proposed mapping and plans (recommended scale of 1" = 50', or greater detail), which illustrates the following at a minimum:

☐ North arrow
☐ Legend
☐ Vicinity map
☐ Existing and proposed topography (minimum of 2-foot contours recommended)
☐ Property lines
☐ Perennial and intermittent streams
☐ Mapping of predominant soils from USDA soils surveys as well as the location of any site-specific test bore hole investigations that may have been conducted and information identifying the hydrologic characteristics and structural properties of soils used in the installation of stormwater management facilities
☐ Boundaries of existing predominant vegetation and proposed limits of clearing and grading
☐ Location and boundaries of natural feature protection and conservation areas (e.g.,wetlands, lakes, ponds, aquifers, public drinking water supplies, etc.) and applicable setbacks (e.g., stream buffers, drinking water well setbacks, septic drainfield setbacks, building setbacks, etc.)
☐ Identification of any on-site or adjacent water bodies included on the Virginia 303(d) list of impaired waters
☐ Current land use and location of existing and proposed roads, buildings, parking lots and other impervious areas
☐ Location and description of any planned demolition of existing structures, roads, etc.
☐ Proposed land use(s) with a tabulation of the percentage of surface area to be adapted to various uses, including but not limited to planned locations of utilities, roads, parking lots, stormwater management facilities, and easements
☐ Location of existing and proposed utilities [e.g., water (including wells), sewer (including septic systems), gas, electric, telecommunications, cable TV, etc.] and easements
☐ Earthwork specifications
☐ Show the BMP name, **geographic coordinates** and design of both structural and non-structural stormwater control measures, including maintenance access and limits of disturbance
☐ Storm drainage plans for site areas not draining to any BMP(s)
☐ Location of existing and proposed conveyance systems, such as storm drains, inlets, catch basins, channels, lateral groundwater movement interceptors (French drains, agric. tile drains, etc.), swales, and areas of overland flow, including grades, dimensions, and direction of flow
☐ Final drainage patterns and flow paths
☐ Location of floodplain/floodway limits and relationship of site to upstream and downstream properties and drainage systems

PROJECT NAME: ____ SUBMITTAL#: _________

PLANS DATED: _____________

☐ Location of all contributing drainage areas and points of stormwater discharge, receiving surface waters or karst features into which stormwater discharges, the pre-development and post-development conditions for drainage areas, and the potential impacts of site stormwater on adjoining parcels
☐ Location and dimensions of proposed channel modifications, such as bridge or culvert crossings
☐ Final stabilization and landscaping plans

______ Hydrologic and hydraulic analysis, including the following:

☐ Site map with locations of design points and drainage areas (size in acres) for runoff calculations
☐ Identification and calculation of stormwater site design credits, if any apply
☐ Summary description of the water quantity and water quality compliance strategy.
☐ Time of concentration (and associated flow paths)
☐ Imperviousness of the entire site and each drainage area
☐ NRCS runoff curve numbers or volumetric runoff coefficients
☐ A hydrologic analysis for the existing (pre-development) conditions, including runoff rates, volumes, and velocities, showing the methodologies used and supporting calculations
☐ A hydrologic analysis for the proposed (post-development) conditions, including runoff rates, volumes, and velocities, showing the methodologies used and supporting calculations
☐ Hydrologic and hydraulic analysis of the stormwater management system for all applicable design storms
☐ Pollution load and load reduction requirements and calculations
☐ Final good engineering and sizing calculations for stormwater control measures, including contributing drainage areas, storage, and outlet configurations, verifying compliance with the water quality and water quantity requirements of the regulations
☐ Stage-discharge or outlet rating curves and inflow and outflow hydrographs for storage facilities
☐ Final analysis of the potential downstream impacts/effects of the project, where necessary
☐ Downstream analysis, where detention is proposed
☐ Dam safety and breach analysis, where necessary

______ Representative cross-section and profile drawings and details of stormwater control measures and conveyances which include the following:
☐ Existing and proposed structural elevations (e.g., inverts of pipes, manholes, etc.)
☐ Design water surface elevations
☐ Structural details of BMP designs, outlet structures, embankments, spillways, grade control structures, conveyance channels, etc.

______ Applicable construction and material specifications, including references to applicable material and construction standards (ASTM, etc.)

______ Landscaping plans for stormwater control measures and any site reforestation or revegetation

PROJECT NAME: ____ SUBMITTAL#: _________

PLANS DATED: _____________

______ Long term operations and maintenance plan/agreement as governed by 9VAC25-870-112 of the Virginia Stormwater Management Program Regulations.

______ Evidence of acquisition of all applicable local and non-local permits

______ Waiver/exception requests

______ Evidence of acquisition of all necessary legal agreements (e.g., easements, covenants, land trusts, etc.)

______ Applicable supporting documents and studies (e.g., infiltration tests, geotechnical investigations, TMDLs, flood studies, etc.)

______ Other required permits: ____

PROJECT NAME: ____ SUBMITTAL#: _________

PLANS DATED: _____________

APPENDIX F:
VIRGINIA STORMWATER MANAGEMENT PROGRAM AUTHORITY MAP

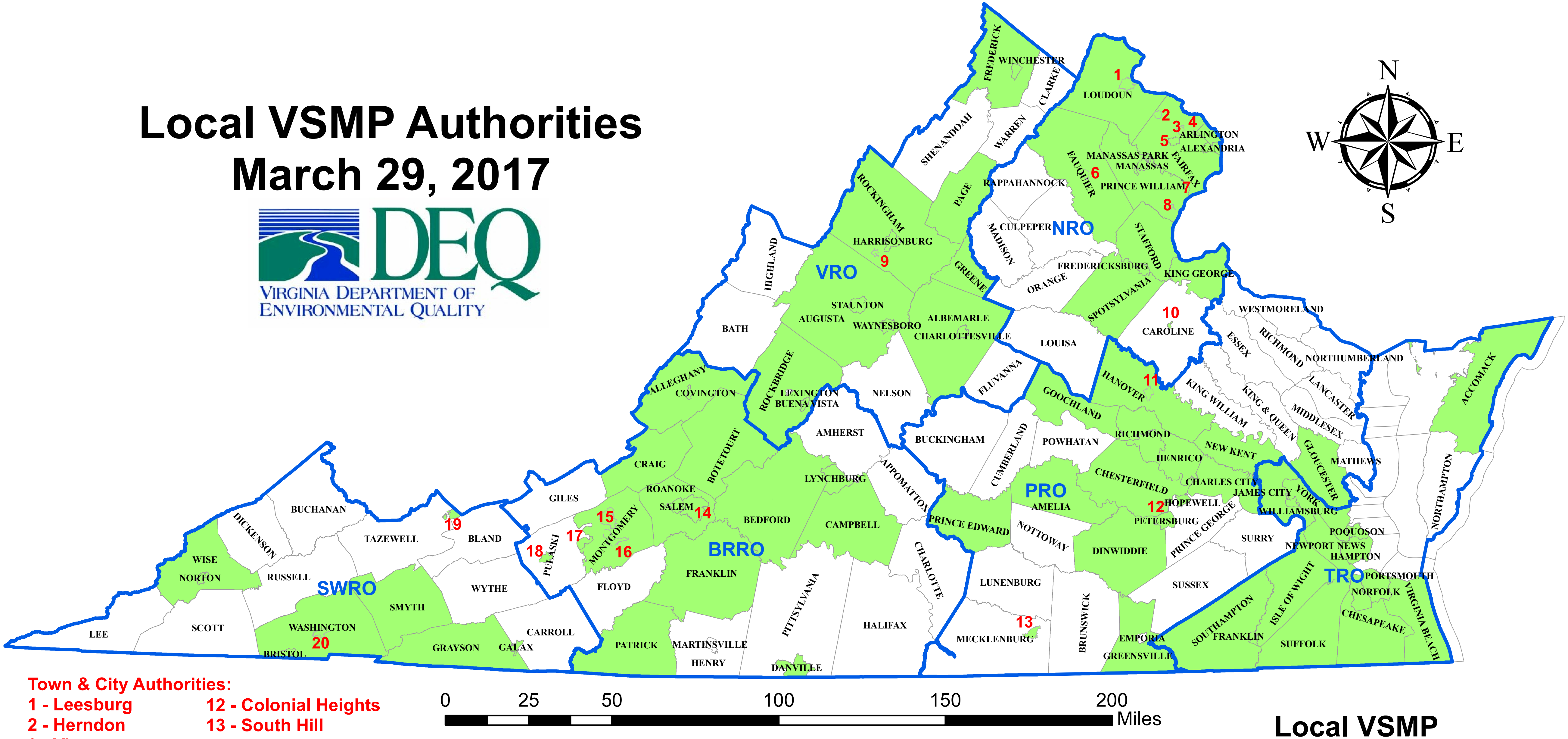
VIRGINIA PROJECTS

September 2019

TC Energy

Local VSMP Authorities
March 29, 2017

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY



Town & City Authorities:

1 - Leesburg
2 - Herndon
3 - Vienna
4 - Falls Church
5 - Fairfax
6 - Warrenton
7 - Occoquan
8 - Dumfries
9 - Bridgewater
10 - Bowling Green
11 - Ashland
12 - Colonial Heights
13 - South Hill
14 - Roanoke
15 - Blacksburg
16 - Christiansburg
17 - Radford
18 - Pulaski
19 - Bluefield
20 - Abingdon

Note: Opt-out totals include counties and cities that did not adopt a local VSMP.

Local VSMP

	DEQ Regional Offices
54	Opt-out
94	Local Authorities

APPENDIX G:
ANNUAL STANDARDS AND SPECIFICATIONS (AS&S) ENTITY INFORMATION FORM

VIRGINIA PROJECTS

September 2019

TC Energy

Annual Standards & Specification (AS&S) Entity Information Sheet

1. Annual Standards & Specifications Entity:		
2. AS&S Coverage Verification		
a. Operator:		
b. Project name:		
c. Estimated Area to be Disturbed (acres):		
3. Plan Approval Verification		
a. Erosion & Sediment Control (ESC) Plan:		
	i. ESC Plan Reviewer Name and Certification Number:	
	ii. ESC Plan Date:	
	iii. ESC Plan Approval Date:	
b. Stormwater Management (SWM) Plan:		
	i. Technical Criteria Used:	
	ii. SWM Plan Reviewer Name and Certification Number:	
	iii. SWM Plan Date:	
	iv. SWM Plan Approval Date:	
4. Comments:		

Printed Name:	**Title:**
Signature:	**Date:**

(Please sign in ink. This must be signed by an employee of the AS&S entity who has oversight of this project and is aware of its coverage under their AS&S.)

(Retain a copy of this form onsite and within project specific AS&S files.)

Instructions for completion:

1. AS&S Entity/Holder Name as it appears on the AS&S Approval Letter
2.a. Operator = Owner, operator, developer, person or general contractor that the AS&S holder is allowing to operate under their DEQ approved AS&S.
2.b. Project Name = Name of the construction activity as it appears on the Registration Statement.
2.c. Estimated Area to Be Disturbed = Provide the estimated area (to the nearest one-hundredth acre) to be disturbed by the construction activity. Include the estimated area of land disturbance that will occur at any off-site support activity to be covered under this general permit.
3.a. Erosion & Sediment Control (ESC) Plans **i.** = AS&S ESC plans are required to be reviewed and approved by DEQ-Certified ESC Plan Reviewers. Provide the name and certification number of the qualified individual. **ii.** = Provide the date of the ESC plan. **iii.** = Provide the date the ESC plan was approved.
3.b. Stormwater Management (SWM) Plans **i.** = The technical criteria used for this project will be either IIB or IIC per the SWM Regulations; 9VAC25-870. **ii.** = AS&S SWM plans are required to be reviewed and approved by DEQ-Certified SWM Plan Reviewers. Provide the name and certification number of the qualified individual. **iii.** = Provide the date of the SWM plan. **iv.** = Provide the date the SWM plan was approved.
4. Comments = Indicate whether the project package contains any requests (e.g. SWM plan waiver, Decline to Permit, Variance, Exception, Deviation…) DEQ is the VESCP and VSMP Authority for AS&S Entities. Approval for such requests must be issued by DEQ.

(Further questions can be directed to StandardsandSpecs@deq.virginia.gov)

APPENDIX H:
EROSION AND SEDIMENT CONTROL INSPECTION LOG

VIRGINIA PROJECTS

June 2020

TC Energy

EROSION AND SEDIMENT CONTROL INSPECTION LOG

Project Name: ______________________________ **Project Location:** ________________________________

Date of Inspection: __________________________ **Inspector:** ______________________________________

❑ **Recent Rainfall Event (Date):** ___________________ **and Approximate Amount (Inch):** ____________________

Weather Conditions (check all that apply):	❑ **Sunny**	❑ **Cloudy**	❑ **Cold**	❑ **Hot**	❑ **Post-Rain Event**
	❑ **Partly Cloudy**	❑ **Windy**	❑ **Mild**	❑ **Rain**	❑ **Other:** _________________

Inspection Type (check all that apply):	❑ **Initial**	❑ **After Storm Event**	❑ **Project Completion**
	❑ **Periodic**	❑ **Other:** ______________________________________	

Stage of Construction:	❑ **Clearing and Grubbing**	❑ **Rough Grading**
	❑ **Finish and Grading**	❑ **Final Stabilization**

Minimum Standards	**YES**	**NO**	**N/A**
Are all denuded areas stabilized? **(MS-1)**	❑	❑	❑
Are all required structural practices installed properly per plan? (**MS-2, 6, 10)**	❑	❑	❑
Does permanent vegetation provide adequate stabilization? **(MS-3)**	❑	❑	❑
Have perimeter sediment trapping facilities been constructed? **(MS-4)**	❑	❑	❑
Are earthen control structures seeded and mulched? **(MS-5)**	❑	❑	❑
Are all finished cut and fill slopes adequately stabilized? **(MS-7)**	❑	❑	❑
Are all channels and outlets adequately stabilized? **(MS-8, 9, 11, 19)**	❑	❑	❑
Is re-stabilization of in-stream construction complete? **(MS-12, 15)**	❑	❑	❑
Are in-stream construction EC properly installed? **(MS-13)**	❑	❑	❑
Are utilities trenches dewatered, backfilled and stabilized? **(MS-16)**	❑	❑	❑
Are construction entrances maintained and soil and mud being kept off public roadways? **(MS-17)**	❑	❑	❑
Have all control structures no longer needed been removed and such areas stabilized? **(MS-18)**	❑	❑	❑
Are adjacent properties and waterways adequately protected? **(MS-19)**	❑	❑	❑
Have all deficiencies from previous inspection been addressed?	❑	❑	❑

Comments:

Action Items:

NOTE: this form should be completed at the appropriate inspection frequency as defined in Annual Standards Section III.A. At a **MINIMUM** this form should be completed:

- During or immediately following initial installation of erosion and sediment controls;
- At least once in every two-week period (or once per week);
- Within 48 hours of a runoff producing storm event; and
- At the completion of the project.

NOTE: completed forms should be maintained onsite during construction.

APPENDIX I:
COMBINED EROSION AND SEDIMENT CONTROL & STORMWATER MANAGEMENT INSPECTION LOG

VIRGINIA PROJECTS

June 2020

TC Energy

EROSION AND SEDIMENT CONTROL INSPECTION LOG

Project Name: ______________________________ **Project Location:** ________________________________

Date of Inspection: __________________________ **Inspector:** ______________________________________

❑ **Recent Rainfall Event (Date):** ___________________ **and Approximate Amount (Inch):** ____________________

Weather Conditions (check all that apply):	❑ **Sunny**	❑ **Cloudy**	❑ **Cold**	❑ **Hot**	❑ **Post-Rain Event**
	❑ **Partly Cloudy**	❑ **Windy**	❑ **Mild**	❑ **Rain**	❑ **Other:** _________________

Inspection Type (check all that apply):	❑ **Initial**	❑ **After Storm Event**	❑ **Project Completion**
	❑ **Periodic**	❑ **Other:** ______________________________________	

Stage of Construction:	❑ **Clearing and Grubbing**	❑ **Rough Grading**
	❑ **Finish and Grading**	❑ **Final Stabilization**

Minimum Standards	**YES**	**NO**	**N/A**
Are all denuded areas stabilized? **(MS-1)**	❑	❑	❑
Are all required structural practices installed properly per plan? (**MS-2, 6, 10**)	❑	❑	❑
Does permanent vegetation provide adequate stabilization? **(MS-3)**	❑	❑	❑
Have perimeter sediment trapping facilities been constructed? **(MS-4)**	❑	❑	❑
Are earthen control structures seeded and mulched? **(MS-5)**	❑	❑	❑
Are all finished cut and fill slopes adequately stabilized? **(MS-7)**	❑	❑	❑
Are all channels and outlets adequately stabilized? **(MS-8, 9, 11, 19)**	❑	❑	❑
Is re-stabilization of in-stream construction complete? **(MS-12, 15)**	❑	❑	❑
Are in-stream construction EC properly installed? **(MS-13)**	❑	❑	❑
Are utilities trenches dewatered, backfilled and stabilized? **(MS-16)**	❑	❑	❑
Are construction entrances maintained and soil and mud being kept off public roadways? **(MS-17)**	❑	❑	❑
Have all control structures no longer needed been removed and such areas stabilized? **(MS-18)**	❑	❑	❑
Are adjacent properties and waterways adequately protected? **(MS-19)**	❑	❑	❑
Have all deficiencies from previous inspection been addressed?	❑	❑	❑

Comments:

Action Items:

NOTE: this form should be completed at the appropriate inspection frequency as defined in Annual Standards Section III.A. At a **MINIMUM** this form should be completed:

- During or immediately following initial installation of erosion and sediment controls;
- At least once in every two-week period (or once per week);
- Within 48 hours of a runoff producing storm event; and
- At the completion of the project.

NOTE: completed forms should be maintained onsite during construction.

STORMWATER MANAGEMENT INSPECTION LOG

NOTE: the Stormwater Management Inspection Log is to be completed **in addition to** the Erosion and Sediment Control Log for **projects with one (1) acre or more of disturbance** (2,500 square feet in Chesapeake Bay Preservation Areas).

NOTE: this form should be completed at the appropriate inspection frequency as defined in Annual Standards Section III.A. At a **MINIMUM** this form should be completed **at the beginning of the project** and **monthly**. Completed forms should be maintained onsite during construction.

Pollution Prevention Requirements	**YES**	**NO**	**N/A**
Are measures and procedures in place to prevent and respond to leaks, spills, and other pollutant releases?	❑	❑	❑
Are measures in place to prevent the release of soaps, solvents, detergents, paint clean-up, and other pollutants and/or contact with stormwater?	❑	❑	❑
Are wash waters from vehicles, equipment, construction materials and the like prevented from release and/or properly treated before leaving the site?	❑	❑	❑
Is the concrete wash-out waste directed into a properly installed and maintained leakproof container?	❑	❑	❑
Are construction products, materials, and wastes being properly stored, handled, labeled? Are loose trash and debris properly contained and trash receptacles covered at the end of each day?	❑	❑	❑
Are other potential pollutant-generating activities not listed above being properly managed to prevent exposure to precipitation/runoff?	❑	❑	❑

Comments Related to Pollution Prevention:

SWPPP Implementation Requirements	**YES**	**NO**	**N/A**
Copy of complete SWPPP available onsite for operators and inspectors?	❑	❑	❑
Is the SWPPP being amended, modified, updated, and appropriately signed?	❑	❑	❑
Are dates when major grading activities occurred properly recorded?	❑	❑	❑
Are SWPPP inspections conducted at required frequency, summarized with corrective actions, appropriately signed, and retained?	❑	❑	❑
Can you certify the work is in compliance with the requirements of the SWPPP?	❑	❑	❑

Comments Related to SWPPP Implementation:

I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: ____ **Date:** _______________ **Report No.:** _______________
(Inspector/Duly Authorized Representative)

STORMWATER MANAGEMENT INSPECTION LOG

NOTE: The Stormwater Management inspection log is to be completed **in addition to** the Erosion and Sediment Control Log for **projects with one (1) acre or more of disturbance** (or 2,500 square feet in Chesapeake Bay Preservation Areas).

NOTE: this page is specifically related to stormwater management features (e.g., ponds) and should be completed **quarterly** at a **MINIMUM**. If no such features exist within the project area, there is no need to complete this page.

[Name of Stormwater Management Feature (e.g., pond, swale)] **Is this Stormwater Management Feature Functioning and Maintained Appropriately?**	**YES**	**NO**	**Description and Comments**
	❑	❑	
	❑	❑	
	❑	❑	
	❑	❑	
	❑	❑	
	❑	❑	

Additional Comments:

I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: ____**Date:** ________________ **Report No.:** ________________
(Inspector/Duly Authorized Representative)

CORRECTIVE ACTION LOG

Project Name: ____

SWPPP Contact: ____

Inspection Date	Inspector Name(s)	Description of BMP Deficiency	Corrective Action Needed (including planned date/responsible person)	Date Action Taken /Responsible person

Items identified herein as needing repair or attention shall be addressed before the next anticipated storm event or as soon as possible to maintain the continued effectiveness of stormwater controls.